US010835250B2

(12) **United States Patent**
Weisenburgh, II et al.

(10) **Patent No.: US 10,835,250 B2**
(45) **Date of Patent: Nov. 17, 2020**

(54) **END EFFECTOR COUPLING ARRANGEMENTS FOR A SURGICAL CUTTING AND STAPLING INSTRUMENT**

(71) Applicant: **Ethicon LLC**, Guaynabo, PR (US)

(72) Inventors: **William B. Weisenburgh, II**, Maineville, OH (US); **Jerome R. Morgan**, Cincinnati, OH (US); **Kyle P. Moore**, Woodstock, GA (US); **Mark H. Ransick**, West Chester, OH (US); **Steven G. Hall**, Cincinnati, OH (US); **Randall J. Tanguay**, Lebanon, OH (US); **Jeffrey D. Messerly**, Cincinnati, OH (US); **Galen C. Robertson**, Apex, NC (US); **Andrew M. Zwolinski**, Cincinnati, OH (US); **Jeffrey S. Swayze**, West Chester, OH (US); **Thomas W. Huitema**, Cincinnati, OH (US); **Glen A. Armstrong**, Hamilton, OH (US); **Shailendra K Parihar**, Mason, OH (US); **Donna L. Korvick**, Bridgewater, NJ (US); **Richard W. Timm**, Cincinnati, OH (US); **Kevin R. Doll**, Mason, OH (US); **Bret W. Smith**, South Lebanon, OH (US); **William D. Kelly**, Mason, OH (US); **Ronald J. Kolata**, Raleigh, NC (US); **Joshua R. Uth**, Mason, OH (US); **Charles J. Scheib**, Loveland, OH (US); **Geoffrey C. Hueil**, Cincinnati, OH (US); **Mark S. Ortiz**, Milford, OH (US); **Douglas B. Hoffman**, Harrison, OH (US); **Patrick A. Weizman**, Liberty Township, OH (US); **Dean B. Bruewer**, Fairfield, OH (US); **Gregory B. Blair**, McCordsville, IN (US); **Frederick E. Shelton, IV**, Hillsboro, OH (US)

(73) Assignee: **Ethicon LLC**, Guaynabo, PR (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 171 days.

(21) Appl. No.: **15/793,527**

(22) Filed: **Oct. 25, 2017**

(65) **Prior Publication Data**

US 2018/0103954 A1 Apr. 19, 2018

Related U.S. Application Data

(63) Continuation of application No. 14/672,620, filed on Mar. 30, 2015, now Pat. No. 9,913,647, which is a

(Continued)

(51) **Int. Cl.**
A61B 17/068 (2006.01)
A61B 17/072 (2006.01)

(Continued)

(52) **U.S. Cl.**
CPC ***A61B 17/105*** (2013.01); ***A61B 17/068*** (2013.01); ***A61B 17/07207*** (2013.01);

(Continued)

(58) **Field of Classification Search**
CPC A61B 17/05; A61B 17/068; A61B 2017/2931

(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,853,074 A 9/1958 Olson
3,079,606 A 3/1963 Bobrov et al.

(Continued)

FOREIGN PATENT DOCUMENTS

AU 2012200178 B2 7/2013
CN 1163558 A 10/1997

(Continued)

OTHER PUBLICATIONS

Serial Communication Protocol; Michael Lemmon Feb. 1, 2009; http://www3.nd.edu/~lemmon/courses/ee224/web-manual/web-manual/lab12/node2.html; Wayback Machine to Apr. 29, 2012.

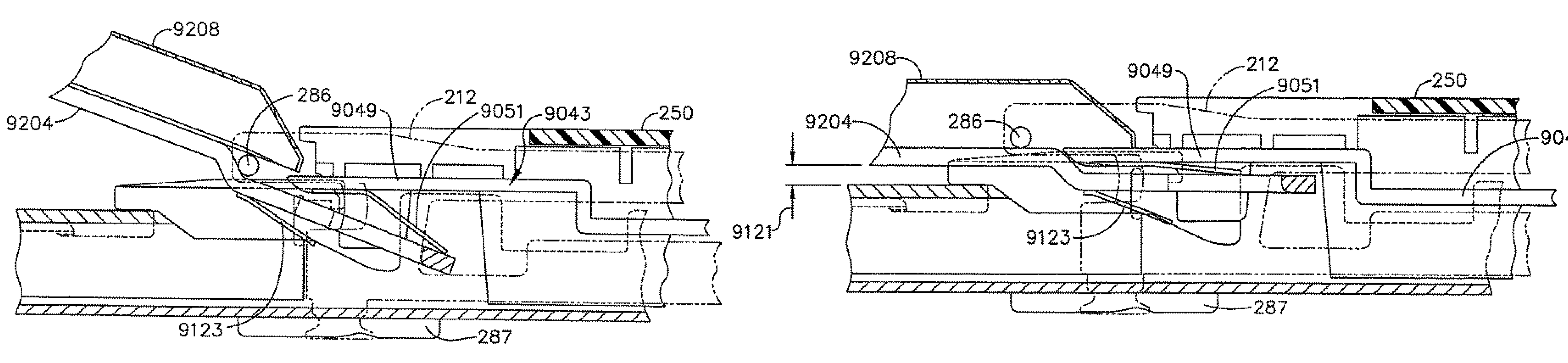
(Continued)

Primary Examiner — Michelle Lopez

(57) **ABSTRACT**

A surgical stapling assembly comprising a firing member, an end effector, a closure member, and a shaft including an attachment interface is disclosed. The surgical stapling assembly is configured to be attached to a surgical instrument interface by way of the attachment interface. The end effector comprises a first jaw, a second jaw, and a staple cartridge comprising staples configured to be ejected by the firing member. The second jaw is movable relative to the

(Continued)



first jaw between an open position, a fully-clamped position, and a collapsed position. The end effector further comprises an interconnection between the first jaw and the second jaw defining a rotational axis about which the second iaw is movable relative to the first iaw. The rotational axis is shiftable toward and away from the first iaw as the second iaw is moved between the open position, the fully-clamped position, and the collapsed position.

9 Claims, 88 Drawing Sheets

Related U.S. Application Data

continuation of application No. 14/528,626, filed on Oct. 30, 2014, now abandoned, which is a continuation of application No. 13/027,641, filed on Feb. 15, 2011, now Pat. No. 8,875,972, which is a continuation of application No. 12/031,817, filed on Feb. 15, 2008, now abandoned.

(51) **Int. Cl.**
A61B 17/10 (2006.01)
A61B 17/3209 (2006.01)
A61B 17/3205 (2006.01)
A61B 17/00 (2006.01)
A61B 17/29 (2006.01)

(52) **U.S. Cl.**
CPC ***A61B 17/3205*** (2013.01); ***A61B 17/3209*** (2013.01); *A61B 2017/00473* (2013.01); *A61B 2017/07214* (2013.01); *A61B 2017/2931* (2013.01)

(58) **Field of Classification Search**
USPC 227/175.1, 175.4
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,490,675 A 1/1970 Green et al.
3,494,533 A 2/1970 Green et al.
3,499,591 A 3/1970 Green
3,551,987 A 1/1971 Wilkinson
3,643,851 A 2/1972 Green et al.
3,662,939 A 5/1972 Bryan
3,717,294 A 2/1973 Green
3,819,100 A 6/1974 Noiles et al.
3,952,747 A 4/1976 Kimmell, Jr.
RE28,932 E 8/1976 Noiles et al.
4,111,206 A 9/1978 Vishnevsky et al.
4,127,227 A 11/1978 Green
4,135,517 A 1/1979 Reale
4,198,982 A 4/1980 Fortner et al.
4,207,898 A 6/1980 Becht
4,272,002 A 6/1981 Moshofsky
4,305,539 A 12/1981 Korolkov et al.
4,331,277 A 5/1982 Green
4,379,457 A 4/1983 Gravener et al.
4,383,634 A 5/1983 Green
4,396,139 A 8/1983 Hall et al.
4,397,311 A 8/1983 Kanshin et al.
4,402,445 A 9/1983 Green
4,415,112 A 11/1983 Green
4,429,695 A 2/1984 Green
4,434,796 A 3/1984 Karapetian et al.
4,438,659 A 3/1984 Desplats
4,475,679 A 10/1984 Fleury, Jr.
4,489,875 A 12/1984 Crawford et al.
4,500,024 A 2/1985 DiGiovanni et al.
4,505,272 A 3/1985 Utyamyshev et al.
4,505,414 A 3/1985 Filipi
4,506,671 A 3/1985 Green
4,520,817 A 6/1985 Green
4,522,327 A 6/1985 Korthoff et al.
4,530,453 A 7/1985 Green
4,566,620 A 1/1986 Green et al.
4,569,469 A 2/1986 Mongeon et al.
4,573,468 A 3/1986 Conta et al.
4,573,622 A 3/1986 Green et al.
4,576,167 A 3/1986 Noiles
4,580,712 A 4/1986 Green
4,585,153 A 4/1986 Failla et al.
4,605,001 A 8/1986 Rothfuss et al.
4,605,004 A 8/1986 Di Giovanni et al.
4,608,981 A 9/1986 Rothfuss et al.
4,610,383 A 9/1986 Rothfuss et al.
4,612,933 A 9/1986 Brinkerhoff et al.
4,619,262 A 10/1986 Taylor
4,619,391 A 10/1986 Sharkany et al.
4,629,107 A 12/1986 Fedotov et al.
4,632,290 A 12/1986 Green et al.
4,633,874 A 1/1987 Chow et al.
4,634,419 A 1/1987 Kreizman et al.
4,652,820 A 3/1987 Maresca
4,662,555 A 5/1987 Thornton
4,664,305 A 5/1987 Blake, III et al.
4,665,916 A 5/1987 Green
4,669,647 A 6/1987 Storace
4,671,445 A 6/1987 Barker et al.
4,684,051 A 8/1987 Akopov et al.
4,700,703 A 10/1987 Resnick et al.
4,708,141 A 11/1987 Inoue et al.
4,715,520 A 12/1987 Roehr, Jr. et al.
4,719,917 A 1/1988 Barrows et al.
4,727,308 A 2/1988 Huljak et al.
4,728,020 A 3/1988 Green et al.
4,747,820 A 5/1988 Hornlein et al.
4,750,902 A 6/1988 Wuchinich et al.
4,752,024 A 6/1988 Green et al.
4,754,909 A 7/1988 Barker et al.
4,767,044 A 8/1988 Green
4,773,420 A 9/1988 Green
4,805,823 A 2/1989 Rothfuss
4,809,695 A 3/1989 Gwathmey et al.
4,817,847 A 4/1989 Redtenbacher et al.
4,819,853 A 4/1989 Green
4,821,939 A 4/1989 Green
4,827,911 A 5/1989 Broadwin et al.
4,844,068 A 7/1989 Arata et al.
4,848,637 A 7/1989 Pruitt
4,865,030 A 9/1989 Polyak
4,869,414 A 9/1989 Green et al.
4,869,415 A 9/1989 Fox
4,873,977 A 10/1989 Avant et al.
4,893,622 A 1/1990 Green et al.
4,896,678 A 1/1990 Ogawa
4,903,697 A 2/1990 Resnick et al.
4,919,679 A 4/1990 Averill et al.
4,930,674 A 6/1990 Barak
4,931,047 A 6/1990 Broadwin et al.
4,938,408 A 7/1990 Bedi et al.
4,941,623 A 7/1990 Pruitt
4,944,443 A 7/1990 Oddsen et al.
4,978,049 A 12/1990 Green
4,978,333 A 12/1990 Broadwin et al.
4,986,808 A 1/1991 Broadwin et al.
5,002,553 A 3/1991 Shiber
5,015,227 A 5/1991 Broadwin et al.
5,038,109 A 8/1991 Goble et al.
5,040,715 A 8/1991 Green et al.
5,065,929 A 11/1991 Schulze et al.
5,074,454 A 12/1991 Peters
5,088,997 A 2/1992 Delahuerga et al.
5,104,397 A 4/1992 Vasconcelos et al.
5,125,876 A 6/1992 Hirota
5,129,570 A 7/1992 Schulze et al.
5,137,198 A 8/1992 Nobis et al.
5,139,513 A 8/1992 Segato
5,141,144 A 8/1992 Foslien et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,156,315	A	10/1992	Green et al.
5,156,614	A	10/1992	Green et al.
5,170,925	A	12/1992	Madden et al.
5,190,517	A	3/1993	Zieve et al.
5,197,649	A	3/1993	Bessler et al.
5,221,036	A	6/1993	Takase
5,221,281	A	6/1993	Klicek
5,240,163	A	8/1993	Stein et al.
5,258,012	A	11/1993	Luscombe et al.
5,263,629	A	11/1993	Trumbull et al.
5,281,216	A	1/1994	Klicek
5,284,128	A	2/1994	Hart
5,289,963	A	3/1994	McGarry et al.
5,307,976	A	5/1994	Olson et al.
5,308,576	A	5/1994	Green et al.
5,312,023	A	5/1994	Green et al.
5,312,329	A	5/1994	Beaty et al.
5,318,221	A	6/1994	Green et al.
5,326,013	A	7/1994	Green et al.
5,332,142	A	7/1994	Robinson et al.
5,333,772	A	8/1994	Rothfuss et al.
5,333,773	A	8/1994	Main et al.
5,346,504	A	9/1994	Ortiz et al.
5,358,506	A	10/1994	Green et al.
5,364,001	A	11/1994	Bryan
5,366,134	A	11/1994	Green et al.
5,370,645	A	12/1994	Klicek et al.
5,372,596	A	12/1994	Klicek et al.
5,374,277	A	12/1994	Hassler
5,382,247	A	1/1995	Cimino et al.
5,383,880	A	1/1995	Hooven
5,389,104	A	2/1995	Hahnen et al.
5,395,033	A	3/1995	Byrne et al.
5,395,384	A	3/1995	Duthoit et al.
5,403,312	A	4/1995	Yates et al.
5,405,072	A	4/1995	Zlock et al.
5,405,344	A	4/1995	Williamson et al.
5,413,272	A	5/1995	Green et al.
5,413,573	A	5/1995	Koivukangas
5,415,334	A	5/1995	Williamson et al.
5,417,361	A	5/1995	Williamson, IV
5,421,829	A	6/1995	Olichney et al.
5,422,567	A	6/1995	Matsunaga
5,423,471	A	6/1995	Mastri et al.
5,423,809	A	6/1995	Klicek
5,431,668	A	7/1995	Burbank, III et al.
5,433,721	A	7/1995	Hooven et al.
5,438,302	A	8/1995	Goble
5,441,483	A	8/1995	Avitall
5,447,265	A	9/1995	Vidal et al.
5,447,417	A	9/1995	Kuhl et al.
5,449,355	A	9/1995	Rhum et al.
5,452,837	A	9/1995	Williamson, IV et al.
5,462,215	A	10/1995	Viola et al.
5,465,819	A	11/1995	Weilant et al.
5,465,896	A	11/1995	Allen et al.
5,466,020	A	11/1995	Page et al.
5,467,911	A	11/1995	Tsuruta et al.
5,472,442	A	12/1995	Klicek
5,474,057	A	12/1995	Makower et al.
5,474,223	A	12/1995	Viola et al.
5,474,566	A	12/1995	Alesi et al.
5,480,089	A	1/1996	Blewett
5,482,197	A	1/1996	Green et al.
5,484,095	A	1/1996	Green et al.
5,484,398	A	1/1996	Stoddard
5,485,947	A	1/1996	Olson et al.
5,485,952	A	1/1996	Fontayne
5,487,499	A	1/1996	Sorrentino et al.
5,487,500	A	1/1996	Knodel et al.
5,489,058	A	2/1996	Plyley et al.
5,496,312	A	3/1996	Klicek
5,496,317	A	3/1996	Goble et al.
5,497,933	A	3/1996	DeFonzo et al.
5,503,320	A	4/1996	Webster et al.
5,503,638	A	4/1996	Cooper et al.
5,505,363	A	4/1996	Green et al.
5,507,426	A	4/1996	Young et al.
5,509,596	A	4/1996	Green et al.
5,509,916	A	4/1996	Taylor
5,520,678	A	5/1996	Heckele et al.
5,529,235	A	6/1996	Boiarski et al.
5,533,661	A	7/1996	Main et al.
5,535,934	A	7/1996	Boiarski et al.
5,535,935	A	7/1996	Vidal et al.
5,535,937	A	7/1996	Boiarski et al.
5,540,375	A	7/1996	Bolanos et al.
5,541,376	A	7/1996	Ladtkow et al.
5,542,594	A	8/1996	McKean et al.
5,547,117	A	8/1996	Hamblin et al.
5,549,637	A	8/1996	Crainich
5,551,622	A	9/1996	Yoon
5,553,765	A	9/1996	Knodel et al.
5,560,530	A	10/1996	Bolanos et al.
5,560,532	A	10/1996	DeFonzo et al.
5,562,239	A	10/1996	Boiarski et al.
5,562,241	A	10/1996	Knodel et al.
5,564,615	A	10/1996	Bishop et al.
5,573,541	A	11/1996	Green et al.
5,577,654	A	11/1996	Bishop
5,579,978	A	12/1996	Green et al.
5,580,067	A	12/1996	Hamblin et al.
5,584,425	A	12/1996	Savage et al.
5,586,711	A	12/1996	Plyley et al.
5,588,579	A	12/1996	Schnut et al.
5,588,580	A	12/1996	Paul et al.
5,588,581	A	12/1996	Conlon et al.
5,597,107	A	1/1997	Knodel et al.
5,599,344	A	2/1997	Paterson
5,601,224	A	2/1997	Bishop et al.
5,603,443	A	2/1997	Clark et al.
5,605,272	A	2/1997	Witt et al.
5,605,273	A	2/1997	Hamblin et al.
5,607,094	A	3/1997	Clark et al.
5,607,095	A	3/1997	Smith et al.
5,609,285	A	3/1997	Grant et al.
5,609,601	A	3/1997	Kolesa et al.
5,611,709	A	3/1997	McAnulty
5,613,966	A	3/1997	Makower et al.
5,615,820	A	4/1997	Viola
5,618,303	A	4/1997	Marlow et al.
5,619,992	A	4/1997	Guthrie et al.
5,628,446	A	5/1997	Geiste et al.
5,628,743	A	5/1997	Cimino
5,628,745	A	5/1997	Bek
5,630,539	A	5/1997	Plyley et al.
5,630,540	A	5/1997	Blewett
5,630,541	A	5/1997	Williamson, IV et al.
5,632,432	A	5/1997	Schulze et al.
5,632,433	A	5/1997	Grant et al.
5,634,584	A	6/1997	Okorocha et al.
5,636,779	A	6/1997	Palmer
5,636,780	A	6/1997	Green et al.
5,639,008	A	6/1997	Gallagher et al.
5,645,209	A	7/1997	Green et al.
5,647,526	A	7/1997	Green et al.
5,647,869	A	7/1997	Goble et al.
5,651,491	A	7/1997	Heaton et al.
5,653,373	A	8/1997	Green et al.
5,653,374	A	8/1997	Young et al.
5,655,698	A	8/1997	Yoon
5,657,921	A	8/1997	Young et al.
5,662,258	A	9/1997	Knodel et al.
5,662,260	A	9/1997	Yoon
5,669,544	A	9/1997	Schulze et al.
5,669,904	A	9/1997	Platt, Jr. et al.
5,669,907	A	9/1997	Platt, Jr. et al.
5,673,840	A	10/1997	Schulze et al.
5,673,841	A	10/1997	Schulze et al.
5,673,842	A	10/1997	Bittner et al.
5,678,748	A	10/1997	Plyley et al.
5,680,981	A	10/1997	Mililli et al.
5,680,982	A	10/1997	Schulze et al.
5,680,983	A	10/1997	Plyley et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,685,474	A	11/1997	Seeber
5,690,269	A	11/1997	Bolanos et al.
5,692,668	A	12/1997	Schulze et al.
5,693,020	A	12/1997	Rauh
5,693,051	A	12/1997	Schulze et al.
5,695,494	A	12/1997	Becker
5,695,504	A	12/1997	Gifford, III et al.
5,697,542	A	12/1997	Knodel et al.
5,697,543	A	12/1997	Burdorff
5,702,387	A	12/1997	Arts et al.
5,704,534	A	1/1998	Huitema et al.
5,706,997	A	1/1998	Green et al.
5,706,998	A	1/1998	Plyley et al.
5,707,392	A	1/1998	Kortenbach
5,709,334	A	1/1998	Sorrentino et al.
5,709,680	A	1/1998	Yates et al.
5,711,472	A	1/1998	Bryan
5,713,505	A	2/1998	Huitema
5,713,895	A	2/1998	Lontine et al.
5,715,604	A	2/1998	Lanzoni
5,715,987	A	2/1998	Kelley et al.
5,715,988	A	2/1998	Palmer
5,718,359	A	2/1998	Palmer et al.
5,718,360	A	2/1998	Green et al.
5,720,744	A	2/1998	Eggleston et al.
5,732,871	A	3/1998	Clark et al.
5,732,872	A	3/1998	Bolduc et al.
5,735,445	A	4/1998	Vidal et al.
5,735,874	A	4/1998	Measamer et al.
5,743,456	A	4/1998	Jones et al.
5,749,893	A	5/1998	Vidal et al.
5,752,644	A	5/1998	Bolanos et al.
5,752,965	A	5/1998	Francis et al.
5,758,814	A	6/1998	Gallagher et al.
5,762,255	A	6/1998	Chrisman et al.
5,762,256	A	6/1998	Mastri et al.
5,772,659	A	6/1998	Becker et al.
5,776,130	A	7/1998	Buysse et al.
5,779,130	A	7/1998	Alesi et al.
5,779,131	A	7/1998	Knodel et al.
5,779,132	A	7/1998	Knodel et al.
5,782,396	A	7/1998	Mastri et al.
5,782,397	A	7/1998	Koukline
5,782,748	A	7/1998	Palmer et al.
5,785,232	A	7/1998	Vidal et al.
5,794,834	A	8/1998	Hamblin et al.
5,797,536	A	8/1998	Smith et al.
5,797,537	A	8/1998	Oberlin et al.
5,797,538	A	8/1998	Heaton et al.
5,799,857	A	9/1998	Robertson et al.
5,800,379	A	9/1998	Edwards
5,807,393	A	9/1998	Williamson, IV et al.
5,810,855	A	9/1998	Rayburn et al.
5,814,055	A	9/1998	Knodel et al.
5,820,009	A	10/1998	Melling et al.
5,826,776	A	10/1998	Schulze et al.
5,827,271	A	10/1998	Buysse et al.
5,829,662	A	11/1998	Allen et al.
5,830,598	A	11/1998	Patterson
5,833,695	A	11/1998	Yoon
5,836,503	A	11/1998	Ehrenfels et al.
5,839,639	A	11/1998	Sauer et al.
5,843,021	A	12/1998	Edwards et al.
5,855,311	A	1/1999	Hamblin et al.
5,860,581	A	1/1999	Robertson et al.
5,860,975	A	1/1999	Goble et al.
5,865,361	A	2/1999	Milliman et al.
5,868,790	A	2/1999	Vincent et al.
5,871,135	A	2/1999	Williamson, IV et al.
5,878,937	A	3/1999	Green et al.
5,878,938	A	3/1999	Bittner et al.
5,893,506	A	4/1999	Powell
5,894,979	A	4/1999	Powell
5,897,552	A	4/1999	Edwards et al.
5,901,895	A	5/1999	Heaton et al.
5,902,312	A	5/1999	Frater et al.
5,908,402	A	6/1999	Blythe
5,911,353	A	6/1999	Bolanos et al.
5,915,616	A	6/1999	Viola et al.
5,918,791	A	7/1999	Sorrentino et al.
5,919,198	A	7/1999	Graves, Jr. et al.
5,937,951	A	8/1999	Izuchukwu et al.
5,941,442	A	8/1999	Geiste et al.
5,944,715	A	8/1999	Goble et al.
5,947,984	A	9/1999	Whipple
5,947,996	A	9/1999	Logeman
5,951,552	A	9/1999	Long et al.
5,954,259	A	9/1999	Viola et al.
5,964,394	A	10/1999	Robertson
5,988,479	A	11/1999	Palmer
6,004,319	A	12/1999	Goble et al.
6,010,054	A	1/2000	Johnson et al.
6,012,494	A	1/2000	Balazs
6,013,076	A	1/2000	Goble et al.
6,015,406	A	1/2000	Goble et al.
6,027,501	A	2/2000	Goble et al.
6,032,849	A	3/2000	Mastri et al.
6,033,399	A	3/2000	Gines
6,039,734	A	3/2000	Goble
6,050,172	A	4/2000	Corves et al.
6,050,472	A	4/2000	Shibata
6,050,996	A	4/2000	Schmaltz et al.
6,053,390	A	4/2000	Green et al.
6,068,627	A	5/2000	Orszulak et al.
6,074,401	A	6/2000	Gardiner et al.
6,079,606	A	6/2000	Milliman et al.
6,083,191	A	7/2000	Rose
6,093,186	A	7/2000	Goble
6,099,551	A	8/2000	Gabbay
6,102,271	A	8/2000	Longo et al.
6,109,500	A	8/2000	Alli et al.
6,117,158	A	9/2000	Measamer et al.
6,119,913	A	9/2000	Adams et al.
6,126,058	A	10/2000	Adams et al.
6,131,789	A	10/2000	Schulze et al.
6,131,790	A	10/2000	Piraka
6,149,660	A	11/2000	Laufer et al.
6,153,292	A	11/2000	Bell et al.
6,155,473	A	12/2000	Tompkins et al.
6,156,056	A	12/2000	Kearns et al.
6,162,208	A	12/2000	Hipps
6,179,195	B1	1/2001	Adams et al.
6,187,003	B1	2/2001	Buysse et al.
6,193,129	B1	2/2001	Bittner et al.
6,202,914	B1	3/2001	Geiste et al.
6,210,403	B1	4/2001	Klicek
6,213,999	B1	4/2001	Platt, Jr. et al.
6,228,081	B1	5/2001	Goble
6,228,083	B1	5/2001	Lands et al.
6,241,139	B1	6/2001	Milliman et al.
6,241,140	B1	6/2001	Adams et al.
6,250,532	B1	6/2001	Green et al.
6,261,286	B1	7/2001	Goble et al.
6,264,086	B1	7/2001	McGuckin, Jr.
6,264,087	B1	7/2001	Whitman
6,273,897	B1	8/2001	Dalessandro et al.
6,277,114	B1	8/2001	Bullivant et al.
6,302,311	B1	10/2001	Adams et al.
6,315,184	B1	11/2001	Whitman
6,322,494	B1	11/2001	Bullivant et al.
6,325,799	B1	12/2001	Goble
6,325,810	B1	12/2001	Hamilton et al.
6,330,965	B1	12/2001	Milliman et al.
6,334,861	B1	1/2002	Chandler et al.
6,336,926	B1	1/2002	Goble
6,343,731	B1	2/2002	Adams et al.
6,358,224	B1	3/2002	Tims et al.
H2037	H	7/2002	Yates et al.
6,439,446	B1	8/2002	Perry et al.
6,443,973	B1	9/2002	Whitman
6,450,391	B1	9/2002	Kayan et al.
6,478,210	B2	11/2002	Adams et al.
6,488,196	B1	12/2002	Fenton, Jr.
6,488,197	B1	12/2002	Whitman

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,491,201	B1	12/2002	Whitman
6,491,690	B1	12/2002	Goble et al.
6,505,768	B2	1/2003	Whitman
6,517,528	B1	2/2003	Pantages et al.
6,517,565	B1	2/2003	Whitman et al.
6,533,157	B1	3/2003	Whitman
6,558,379	B1	5/2003	Batchelor et al.
6,569,085	B2	5/2003	Kortenbach et al.
6,578,751	B2	6/2003	Hartwick
6,585,144	B2	7/2003	Adams et al.
6,588,643	B2	7/2003	Bolduc et al.
6,589,118	B1	7/2003	Soma et al.
6,592,597	B2	7/2003	Grant et al.
6,601,749	B2	8/2003	Sullivan et al.
6,607,475	B2	8/2003	Doyle et al.
6,616,686	B2	9/2003	Coleman et al.
6,619,529	B2	9/2003	Green et al.
6,629,630	B2	10/2003	Adams
6,629,988	B2	10/2003	Weadock
6,644,532	B2	11/2003	Green et al.
6,656,193	B2	12/2003	Grant et al.
6,669,073	B2	12/2003	Milliman et al.
6,670,806	B2	12/2003	Wendt et al.
6,676,660	B2	1/2004	Wampler et al.
6,681,978	B2	1/2004	Geiste et al.
6,681,979	B2	1/2004	Whitman
6,695,198	B2	2/2004	Adams et al.
6,695,199	B2	2/2004	Whitman
6,698,643	B2	3/2004	Whitman
6,722,552	B2	4/2004	Fenton, Jr.
6,723,109	B2	4/2004	Solingen
6,726,697	B2	4/2004	Nicholas et al.
6,749,560	B1	6/2004	Konstorum et al.
6,755,338	B2	6/2004	Hahnen et al.
6,761,685	B2	7/2004	Adams et al.
6,769,590	B2	8/2004	Vresh et al.
6,769,594	B2	8/2004	Orban, III
6,773,437	B2	8/2004	Ogilvie et al.
6,786,382	B1	9/2004	Hoffman
6,793,652	B1	9/2004	Whitman et al.
6,793,661	B2	9/2004	Hamilton et al.
6,805,273	B2	10/2004	Bilotti et al.
6,817,508	B1	11/2004	Racenet et al.
6,817,509	B2	11/2004	Geiste et al.
6,817,974	B2	11/2004	Cooper et al.
6,820,791	B2	11/2004	Adams
6,827,246	B2	12/2004	Sullivan et al.
6,830,174	B2	12/2004	Hillstead et al.
6,835,336	B2	12/2004	Watt
6,840,423	B2	1/2005	Adams et al.
6,843,403	B2	1/2005	Whitman
6,858,005	B2	2/2005	Ohline et al.
RE38,708	E	3/2005	Bolanos et al.
6,866,178	B2	3/2005	Adams et al.
6,874,669	B2	4/2005	Adams et al.
6,877,647	B2	4/2005	Green et al.
6,878,106	B1	4/2005	Herrmann
6,905,057	B2	6/2005	Swayze et al.
6,908,472	B2	6/2005	Wiener et al.
6,932,810	B2	8/2005	Ryan
6,945,444	B2	9/2005	Gresham et al.
6,951,562	B2	10/2005	Zwirnmann
6,953,138	B1	10/2005	Dworak et al.
6,953,139	B2	10/2005	Milliman et al.
6,958,035	B2	10/2005	Friedman et al.
6,959,851	B2	11/2005	Heinrich
6,959,852	B2	11/2005	Shelton, IV et al.
6,964,363	B2	11/2005	Wales et al.
6,978,921	B2	12/2005	Shelton, IV et al.
6,978,922	B2	12/2005	Bilotti et al.
6,981,628	B2	1/2006	Wales
6,984,231	B2	1/2006	Goble et al.
6,986,451	B1	1/2006	Mastri et al.
6,988,649	B2	1/2006	Shelton, IV et al.
6,988,650	B2	1/2006	Schwemberger et al.
6,995,729	B2	2/2006	Govari et al.
7,000,818	B2	2/2006	Shelton, IV et al.
7,000,819	B2	2/2006	Swayze et al.
7,001,408	B2	2/2006	Knodel et al.
7,008,435	B2	3/2006	Cummins
7,018,357	B2	3/2006	Emmons
7,023,159	B2	4/2006	Gorti et al.
7,032,798	B2	4/2006	Whitman et al.
7,032,799	B2	4/2006	Viola et al.
7,044,352	B2	5/2006	Shelton, IV et al.
7,044,353	B2	5/2006	Mastri et al.
7,052,494	B2	5/2006	Goble et al.
7,055,730	B2	6/2006	Ehrenfels et al.
7,055,731	B2	6/2006	Shelton, IV et al.
7,059,508	B2	6/2006	Shelton, IV et al.
7,070,083	B2	7/2006	Jankowski
7,080,769	B2	7/2006	Vresh et al.
7,083,075	B2	8/2006	Swayze et al.
7,097,089	B2	8/2006	Marczyk
7,097,644	B2	8/2006	Long
7,111,769	B2	9/2006	Wales et al.
7,114,642	B2	10/2006	Whitman
7,119,534	B2	10/2006	Butzmann
7,121,446	B2	10/2006	Arad et al.
7,122,028	B2	10/2006	Looper et al.
7,128,253	B2	10/2006	Mastri et al.
7,128,254	B2	10/2006	Shelton, IV et al.
7,128,748	B2	10/2006	Mooradian et al.
7,133,601	B2	11/2006	Phillips et al.
7,134,587	B2	11/2006	Schwemberger et al.
7,137,981	B2	11/2006	Long
7,140,527	B2	11/2006	Ehrenfels et al.
7,140,528	B2	11/2006	Shelton, IV
7,143,923	B2	12/2006	Shelton, IV et al.
7,143,924	B2	12/2006	Scirica et al.
7,143,925	B2	12/2006	Shelton, IV et al.
7,143,926	B2	12/2006	Shelton, IV et al.
7,147,138	B2	12/2006	Shelton, IV
7,147,139	B2	12/2006	Schwemberger et al.
7,147,140	B2	12/2006	Wukusick et al.
7,147,637	B2	12/2006	Goble
7,147,650	B2	12/2006	Lee
7,150,748	B2	12/2006	Ebbutt et al.
7,156,824	B2	1/2007	Rosenman
7,159,750	B2	1/2007	Racenet et al.
7,168,604	B2	1/2007	Milliman et al.
7,172,104	B2	2/2007	Scirica et al.
7,179,267	B2	2/2007	Nolan et al.
7,182,239	B1	2/2007	Myers
7,188,758	B2	3/2007	Viola et al.
7,199,537	B2	4/2007	Okamura et al.
7,204,404	B2	4/2007	Nguyen et al.
7,204,835	B2	4/2007	Latterell et al.
7,207,471	B2	4/2007	Heinrich et al.
7,207,472	B2	4/2007	Wukusick et al.
7,210,609	B2	5/2007	Leiboff et al.
7,211,081	B2	5/2007	Goble
7,213,736	B2	5/2007	Wales et al.
7,220,272	B2	5/2007	Weadock
7,225,963	B2	6/2007	Scirica
7,225,964	B2	6/2007	Mastri et al.
7,234,624	B2	6/2007	Gresham et al.
7,237,708	B1	7/2007	Guy et al.
7,238,195	B2	7/2007	Viola
7,241,289	B2	7/2007	Braun
7,246,734	B2	7/2007	Shelton, IV
7,247,161	B2	7/2007	Johnston et al.
7,258,262	B2	8/2007	Mastri et al.
7,258,546	B2	8/2007	Beier et al.
7,278,562	B2	10/2007	Mastri et al.
7,278,563	B1	10/2007	Green
7,282,048	B2	10/2007	Goble et al.
7,287,682	B1	10/2007	Ezzat et al.
7,293,685	B2	11/2007	Ehrenfels et al.
7,296,722	B2	11/2007	Ivanko
7,296,724	B2	11/2007	Green et al.
7,300,450	B2	11/2007	Vleugels et al.
7,303,106	B2	12/2007	Milliman et al.
7,303,107	B2	12/2007	Milliman et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,303,108	B2	12/2007	Shelton, IV
7,308,998	B2	12/2007	Mastri et al.
7,322,994	B2	1/2008	Nicholas et al.
7,326,203	B2	2/2008	Papineau et al.
7,328,828	B2	2/2008	Ortiz et al.
7,328,829	B2	2/2008	Arad et al.
7,331,340	B2	2/2008	Barney
7,331,969	B1	2/2008	Inganas et al.
7,334,717	B2	2/2008	Rethy et al.
7,334,718	B2	2/2008	McAlister et al.
7,336,048	B2	2/2008	Lohr
RE40,237	E	4/2008	Bilotti et al.
7,354,447	B2	4/2008	Shelton, IV et al.
7,357,287	B2	4/2008	Shelton, IV et al.
7,357,806	B2	4/2008	Rivera et al.
7,364,060	B2	4/2008	Milliman
7,364,061	B2	4/2008	Swayze et al.
7,380,695	B2	6/2008	Doll et al.
7,380,696	B2	6/2008	Shelton, IV et al.
7,396,356	B2	7/2008	Mollenauer
7,398,907	B2	7/2008	Racenet et al.
7,398,908	B2	7/2008	Holsten et al.
7,401,721	B2	7/2008	Holsten et al.
7,404,508	B2	7/2008	Smith et al.
7,404,509	B2	7/2008	Ortiz et al.
7,404,822	B2	7/2008	Viart et al.
7,407,074	B2	8/2008	Ortiz et al.
7,407,075	B2	8/2008	Holsten et al.
7,407,076	B2	8/2008	Racenet et al.
7,407,077	B2	8/2008	Ortiz et al.
7,407,078	B2	8/2008	Shelton, IV et al.
7,410,086	B2	8/2008	Ortiz et al.
7,416,101	B2	8/2008	Shelton, IV et al.
RE40,514	E	9/2008	Mastri et al.
7,419,080	B2	9/2008	Smith et al.
7,419,081	B2	9/2008	Ehrenfels et al.
7,419,321	B2	9/2008	Tereschouk
7,422,136	B1	9/2008	Marczyk
7,422,138	B2	9/2008	Bilotti et al.
7,422,139	B2	9/2008	Shelton, IV et al.
7,424,965	B2	9/2008	Racenet et al.
7,427,607	B2	9/2008	Suzuki
7,431,188	B1	10/2008	Marczyk
7,431,189	B2	10/2008	Shelton, IV et al.
7,431,694	B2	10/2008	Stefanchik et al.
7,431,730	B2	10/2008	Viola
7,434,715	B2	10/2008	Shelton, IV et al.
7,434,717	B2	10/2008	Shelton, IV et al.
7,438,209	B1	10/2008	Hess et al.
7,438,718	B2	10/2008	Milliman et al.
7,441,684	B2	10/2008	Shelton, IV et al.
7,441,685	B1	10/2008	Boudreaux
7,448,525	B2	11/2008	Shelton, IV et al.
7,451,904	B2	11/2008	Shelton, IV
7,455,208	B2	11/2008	Wales et al.
7,461,767	B2	12/2008	Viola et al.
7,464,846	B2	12/2008	Shelton, IV et al.
7,464,847	B2	12/2008	Viola et al.
7,464,849	B2	12/2008	Shelton, IV et al.
7,467,740	B2	12/2008	Shelton, IV et al.
7,472,814	B2	1/2009	Mastri et al.
7,472,815	B2	1/2009	Shelton, IV et al.
7,472,816	B2	1/2009	Holsten et al.
7,473,253	B2	1/2009	Dycus et al.
7,481,347	B2	1/2009	Roy
7,481,348	B2	1/2009	Marczyk
7,481,349	B2	1/2009	Holsten et al.
7,487,899	B2	2/2009	Shelton, IV et al.
7,490,749	B2	2/2009	Schall et al.
7,494,039	B2	2/2009	Racenet et al.
7,500,979	B2	3/2009	Hueil et al.
7,503,474	B2	3/2009	Hillstead et al.
7,506,790	B2	3/2009	Shelton, IV
7,506,791	B2	3/2009	Omaits et al.
7,510,107	B2	3/2009	Timm et al.
7,513,408	B2	4/2009	Shelton, IV et al.
7,517,356	B2	4/2009	Heinrich
7,546,939	B2	6/2009	Adams et al.
7,546,940	B2	6/2009	Milliman et al.
7,547,312	B2	6/2009	Bauman et al.
7,549,563	B2	6/2009	Mather et al.
7,549,564	B2	6/2009	Boudreaux
7,549,998	B2	6/2009	Braun
7,552,854	B2	6/2009	Wixey et al.
7,556,185	B2	7/2009	Viola
7,556,186	B2	7/2009	Milliman
7,559,449	B2	7/2009	Viola
7,559,450	B2	7/2009	Wales et al.
7,559,452	B2	7/2009	Wales et al.
7,565,993	B2	7/2009	Milliman et al.
7,568,603	B2	8/2009	Shelton, IV et al.
7,568,604	B2	8/2009	Ehrenfels et al.
7,575,144	B2	8/2009	Ortiz et al.
7,588,174	B2	9/2009	Holsten et al.
7,588,175	B2	9/2009	Timm et al.
7,588,176	B2	9/2009	Timm et al.
7,588,177	B2	9/2009	Racenet
7,597,229	B2	10/2009	Boudreaux et al.
7,597,230	B2	10/2009	Racenet et al.
7,600,663	B2	10/2009	Green
7,604,150	B2	10/2009	Boudreaux
7,604,151	B2	10/2009	Hess et al.
7,607,557	B2	10/2009	Shelton, IV et al.
7,615,067	B2	11/2009	Lee et al.
7,617,961	B2	11/2009	Viola
7,624,902	B2	12/2009	Marczyk et al.
7,624,903	B2	12/2009	Green et al.
7,625,370	B2	12/2009	Hart et al.
7,631,793	B2	12/2009	Rethy et al.
7,631,794	B2	12/2009	Rethy et al.
7,635,074	B2	12/2009	Olson et al.
7,637,409	B2	12/2009	Marczyk
7,637,410	B2	12/2009	Marczyk
7,638,958	B2	12/2009	Philipp et al.
7,641,091	B2	1/2010	Olson et al.
7,641,092	B2	1/2010	Kruszynski et al.
7,641,093	B2	1/2010	Doll et al.
7,641,095	B2	1/2010	Viola
7,644,848	B2	1/2010	Swayze et al.
7,645,230	B2	1/2010	Mikkaichi et al.
7,651,017	B2	1/2010	Ortiz et al.
7,654,431	B2	2/2010	Hueil et al.
7,658,311	B2	2/2010	Boudreaux
7,658,312	B2	2/2010	Vidal et al.
7,662,161	B2	2/2010	Briganti et al.
7,665,646	B2	2/2010	Prommersberger
7,665,647	B2	2/2010	Shelton, IV et al.
7,669,746	B2	3/2010	Shelton, IV
7,669,747	B2	3/2010	Weisenburgh, II et al.
7,670,334	B2	3/2010	Hueil et al.
7,673,780	B2	3/2010	Shelton, IV et al.
7,673,781	B2	3/2010	Swayze et al.
7,673,782	B2	3/2010	Hess et al.
7,673,783	B2	3/2010	Morgan et al.
7,686,201	B2	3/2010	Csiky
7,694,865	B2	4/2010	Scirica
7,695,485	B2	4/2010	Whitman et al.
7,699,204	B2	4/2010	Viola
7,699,846	B2	4/2010	Ryan
7,699,856	B2	4/2010	Van Wyk et al.
7,703,653	B2	4/2010	Shah et al.
7,708,180	B2	5/2010	Murray et al.
7,708,181	B2	5/2010	Cole et al.
7,708,182	B2	5/2010	Viola
7,708,758	B2	5/2010	Lee et al.
7,717,312	B2	5/2010	Beetel
7,717,313	B2	5/2010	Criscuolo et al.
7,717,846	B2	5/2010	Zirps et al.
7,721,930	B2	5/2010	McKenna et al.
7,721,931	B2	5/2010	Shelton, IV et al.
7,721,933	B2	5/2010	Ehrenfels et al.
7,721,934	B2	5/2010	Shelton, IV et al.
7,721,936	B2	5/2010	Shalton, IV et al.
7,725,214	B2	5/2010	Diolaiti

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,726,537	B2	6/2010	Olson et al.
7,726,538	B2	6/2010	Holsten et al.
7,726,539	B2	6/2010	Holsten et al.
7,731,072	B2	6/2010	Timm et al.
7,731,073	B2	6/2010	Wixey et al.
7,735,703	B2	6/2010	Morgan et al.
7,738,971	B2	6/2010	Swayze et al.
7,740,159	B2	6/2010	Shelton, IV et al.
7,743,960	B2	6/2010	Whitman et al.
7,744,627	B2	6/2010	Orban, III et al.
7,751,870	B2	7/2010	Whitman
7,753,245	B2	7/2010	Boudreaux et al.
7,753,904	B2	7/2010	Shelton, IV et al.
7,766,209	B2	8/2010	Baxter, III et al.
7,766,210	B2	8/2010	Shelton, IV et al.
7,770,773	B2	8/2010	Whitman et al.
7,770,774	B2	8/2010	Mastri et al.
7,770,775	B2	8/2010	Shelton, IV et al.
7,770,776	B2	8/2010	Chen et al.
7,780,054	B2	8/2010	Wales
7,780,055	B2	8/2010	Scirica et al.
7,784,662	B2	8/2010	Wales et al.
7,784,663	B2	8/2010	Shelton, IV
7,793,812	B2	9/2010	Moore et al.
7,794,475	B2	9/2010	Hess et al.
7,798,386	B2	9/2010	Schall et al.
7,799,039	B2	9/2010	Shelton, IV et al.
7,803,151	B2	9/2010	Whitman
7,810,690	B2	10/2010	Bilotti et al.
7,810,691	B2	10/2010	Boyden et al.
7,810,692	B2	10/2010	Hall et al.
7,810,693	B2	10/2010	Broehl et al.
7,815,092	B2	10/2010	Whitman et al.
7,819,296	B2	10/2010	Hueil et al.
7,819,297	B2	10/2010	Doll et al.
7,819,298	B2	10/2010	Hall et al.
7,819,299	B2	10/2010	Shelton, IV et al.
7,823,592	B2	11/2010	Bettuchi et al.
7,823,760	B2	11/2010	Zemlok et al.
7,828,189	B2	11/2010	Holsten et al.
7,832,408	B2	11/2010	Shelton, IV et al.
7,832,611	B2	11/2010	Boyden et al.
7,832,612	B2	11/2010	Baxter, III et al.
7,837,079	B2	11/2010	Holsten et al.
7,837,080	B2	11/2010	Schwemberger
7,837,081	B2	11/2010	Holsten et al.
7,837,694	B2	11/2010	Tethrake et al.
7,841,503	B2	11/2010	Sonnenschein et al.
7,842,028	B2	11/2010	Lee
7,845,533	B2	12/2010	Marczyk et al.
7,845,534	B2	12/2010	Viola et al.
7,845,535	B2	12/2010	Scircia
7,845,536	B2	12/2010	Viola et al.
7,845,537	B2	12/2010	Shelton, IV et al.
7,854,736	B2	12/2010	Ryan
7,857,183	B2	12/2010	Shelton, IV
7,857,185	B2	12/2010	Swayze et al.
7,857,186	B2	12/2010	Baxter, III et al.
7,861,906	B2	1/2011	Doll et al.
7,866,525	B2	1/2011	Scirica
7,866,527	B2	1/2011	Hall et al.
7,866,528	B2	1/2011	Olson et al.
7,870,989	B2	1/2011	Viola et al.
7,886,951	B2	2/2011	Hessler
7,886,952	B2	2/2011	Scirica et al.
7,887,530	B2	2/2011	Zemlok et al.
7,887,563	B2	2/2011	Cummins
7,891,531	B1	2/2011	Ward
7,891,532	B2	2/2011	Mastri et al.
7,892,245	B2	2/2011	Liddicoat et al.
7,893,586	B2	2/2011	West et al.
7,896,214	B2	3/2011	Farascioni
7,896,215	B2	3/2011	Adams et al.
7,896,877	B2	3/2011	Hall et al.
7,900,805	B2	3/2011	Shelton, IV et al.
7,905,380	B2	3/2011	Shelton, IV et al.
7,905,381	B2	3/2011	Baxter, III et al.
7,905,893	B2	3/2011	Kuhns et al.
7,909,039	B2	3/2011	Hur
7,909,220	B2	3/2011	Viola
7,909,221	B2	3/2011	Viola et al.
7,913,891	B2	3/2011	Doll et al.
7,913,893	B2	3/2011	Mastri et al.
7,918,230	B2	4/2011	Whitman et al.
7,918,376	B1	4/2011	Knodel et al.
7,918,377	B2	4/2011	Measamer et al.
7,918,845	B2	4/2011	Saadat et al.
7,922,061	B2	4/2011	Shelton, IV et al.
7,922,063	B2	4/2011	Zemlok et al.
7,922,743	B2	4/2011	Heinrich et al.
7,926,691	B2	4/2011	Viola et al.
7,931,660	B2	4/2011	Aranyi et al.
7,934,630	B2	5/2011	Shelton, IV et al.
7,934,631	B2	5/2011	Balbierz et al.
7,935,773	B2	5/2011	Hadba et al.
7,938,307	B2	5/2011	Bettuchi
7,942,303	B2	5/2011	Shah
7,942,890	B2	5/2011	D'Agostino et al.
7,950,560	B2	5/2011	Zemlok et al.
7,950,561	B2	5/2011	Aranyi
7,951,071	B2	5/2011	Whitman et al.
7,954,682	B2	6/2011	Giordano et al.
7,954,684	B2	6/2011	Boudreaux
7,954,686	B2	6/2011	Baxter, III et al.
7,954,687	B2	6/2011	Zemlok et al.
7,959,050	B2	6/2011	Smith et al.
7,959,051	B2	6/2011	Smith et al.
7,959,052	B2	6/2011	Sonnenschein et al.
7,963,432	B2	6/2011	Knodel et al.
7,963,433	B2	6/2011	Whitman et al.
7,966,799	B2	6/2011	Morgan et al.
7,967,178	B2	6/2011	Scirica et al.
7,967,179	B2	6/2011	Olson et al.
7,967,180	B2	6/2011	Scirica
7,967,181	B2	6/2011	Viola et al.
7,967,839	B2	6/2011	Flock et al.
7,972,298	B2	7/2011	Wallace et al.
7,976,563	B2	7/2011	Summerer
7,980,443	B2	7/2011	Scheib et al.
7,988,026	B2	8/2011	Knodel et al.
7,988,027	B2	8/2011	Olson et al.
7,988,028	B2	8/2011	Farascioni et al.
7,988,779	B2	8/2011	Disalvo et al.
7,992,757	B2	8/2011	Wheeler et al.
7,997,468	B2	8/2011	Farascioni
7,997,469	B2	8/2011	Olson et al.
8,002,795	B2	8/2011	Beetel
8,006,885	B2	8/2011	Marczyk
8,006,889	B2	8/2011	Adams et al.
8,011,550	B2	9/2011	Aranyi et al.
8,011,551	B2	9/2011	Marczyk et al.
8,011,553	B2	9/2011	Mastri et al.
8,011,555	B2	9/2011	Tarinelli et al.
8,016,176	B2	9/2011	Kasvikis et al.
8,016,177	B2	9/2011	Bettuchi et al.
8,016,178	B2	9/2011	Olson et al.
8,016,849	B2	9/2011	Wenchell
8,016,855	B2	9/2011	Whitman et al.
8,016,858	B2	9/2011	Whitman
8,020,742	B2	9/2011	Marczyk
8,020,743	B2	9/2011	Shelton, IV
8,021,377	B2	9/2011	Eskuri
8,025,199	B2	9/2011	Whitman et al.
8,028,883	B2	10/2011	Stopek
8,028,884	B2	10/2011	Sniffin et al.
8,028,885	B2	10/2011	Smith et al.
8,033,438	B2	10/2011	Scirica
8,033,440	B2	10/2011	Wenchell et al.
8,035,487	B2	10/2011	Malackowski
8,038,045	B2	10/2011	Bettuchi et al.
8,038,046	B2	10/2011	Smith et al.
8,047,236	B2	11/2011	Perry
8,056,787	B2	11/2011	Boudreaux et al.
8,056,788	B2	11/2011	Mastri et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,061,576	B2	11/2011	Cappola
8,062,330	B2	11/2011	Prommersberger et al.
8,066,166	B2	11/2011	Demmy et al.
8,066,167	B2	11/2011	Measamer et al.
8,066,168	B2	11/2011	Vidal et al.
D650,074	S	12/2011	Hunt et al.
8,070,035	B2	12/2011	Holsten et al.
8,083,118	B2	12/2011	Milliman et al.
8,083,119	B2	12/2011	Prommersberger
8,083,120	B2	12/2011	Shelton, IV et al.
8,091,756	B2	1/2012	Viola
8,092,932	B2	1/2012	Phillips et al.
8,096,458	B2	1/2012	Hessler
8,097,017	B2	1/2012	Viola
8,100,310	B2	1/2012	Zemlok
8,105,350	B2	1/2012	Lee et al.
8,109,426	B2	2/2012	Milliman et al.
8,113,405	B2	2/2012	Milliman
8,113,410	B2	2/2012	Hall et al.
8,114,100	B2	2/2012	Smith et al.
8,123,103	B2	2/2012	Milliman
8,127,975	B2	3/2012	Olson et al.
8,127,976	B2	3/2012	Scirica et al.
8,132,703	B2	3/2012	Milliman et al.
8,132,706	B2	3/2012	Marczyk et al.
8,136,712	B2	3/2012	Zingman
8,136,713	B2	3/2012	Hathaway et al.
8,140,417	B2	3/2012	Shibata
8,141,762	B2	3/2012	Bedi et al.
8,141,763	B2	3/2012	Milliman
8,146,790	B2	4/2012	Milliman
8,152,041	B2	4/2012	Kostrzewski
8,152,756	B2	4/2012	Webster et al.
8,157,145	B2	4/2012	Shelton, IV et al.
8,157,148	B2	4/2012	Scirica
8,157,151	B2	4/2012	Ingmanson et al.
8,157,152	B2	4/2012	Holsten et al.
8,157,153	B2	4/2012	Shelton, IV et al.
8,161,977	B2	4/2012	Shelton, IV et al.
8,162,197	B2	4/2012	Mastri et al.
8,167,185	B2	5/2012	Shelton, IV et al.
8,172,120	B2	5/2012	Boyden et al.
8,172,122	B2	5/2012	Kasvikis et al.
8,172,124	B2	5/2012	Shelton, IV et al.
8,177,797	B2	5/2012	Shimoji et al.
8,181,840	B2	5/2012	Milliman
8,186,555	B2	5/2012	Shelton, IV et al.
8,186,560	B2	5/2012	Hess et al.
8,191,752	B2	6/2012	Scirica
8,196,795	B2	6/2012	Moore et al.
8,196,796	B2	6/2012	Shelton, IV et al.
8,201,720	B2	6/2012	Hessler
8,201,721	B2	6/2012	Zemlok et al.
8,205,779	B2	6/2012	Ma et al.
8,205,780	B2	6/2012	Sorrentino et al.
8,205,781	B2	6/2012	Baxter, III et al.
8,210,411	B2	7/2012	Yates et al.
8,210,414	B2	7/2012	Bettuchi et al.
8,210,415	B2	7/2012	Ward
8,210,416	B2	7/2012	Milliman et al.
8,214,019	B2	7/2012	Govari et al.
8,215,531	B2	7/2012	Shelton, IV et al.
8,215,533	B2	7/2012	Viola et al.
8,220,688	B2	7/2012	Laurent et al.
8,220,690	B2	7/2012	Hess et al.
8,231,040	B2	7/2012	Zemlok et al.
8,231,042	B2	7/2012	Hessler et al.
8,231,043	B2	7/2012	Tarinelli et al.
8,236,010	B2	8/2012	Ortiz et al.
8,241,322	B2	8/2012	Whitman et al.
8,245,898	B2	8/2012	Smith et al.
8,245,899	B2	8/2012	Swensgard et al.
8,245,900	B2	8/2012	Scirica
8,245,901	B2	8/2012	Stopek
8,246,637	B2	8/2012	Viola et al.
8,256,654	B2	9/2012	Bettuchi et al.
8,256,655	B2	9/2012	Sniffin et al.
8,256,656	B2	9/2012	Milliman et al.
8,267,300	B2	9/2012	Boudreaux
8,272,553	B2	9/2012	Mastri et al.
8,272,554	B2	9/2012	Whitman et al.
8,276,801	B2	10/2012	Zemlok et al.
8,276,802	B2	10/2012	Kostrzewski
8,281,973	B2	10/2012	Wenchell et al.
8,281,974	B2	10/2012	Hessler et al.
8,286,845	B2	10/2012	Perry et al.
8,286,846	B2	10/2012	Smith et al.
8,292,150	B2	10/2012	Bryant
8,292,151	B2	10/2012	Viola
8,292,155	B2	10/2012	Shelton, IV et al.
8,292,157	B2	10/2012	Smith et al.
8,292,888	B2	10/2012	Whitman
8,308,040	B2	11/2012	Huang et al.
8,308,042	B2	11/2012	Aranyi
8,308,043	B2	11/2012	Bindra et al.
8,308,046	B2	11/2012	Prommersberger
8,313,496	B2	11/2012	Sauer et al.
8,317,070	B2	11/2012	Hueil et al.
8,317,071	B1	11/2012	Knodel
8,317,074	B2	11/2012	Ortiz et al.
8,317,744	B2	11/2012	Kirschenman
8,322,455	B2	12/2012	Shelton, IV et al.
8,322,589	B2	12/2012	Boudreaux
8,322,590	B2	12/2012	Patel et al.
8,328,061	B2	12/2012	Kasvikis
8,328,062	B2	12/2012	Viola
8,328,063	B2	12/2012	Milliman et al.
8,328,064	B2	12/2012	Racenet et al.
8,333,313	B2	12/2012	Boudreaux et al.
8,333,764	B2	12/2012	Francischelli et al.
8,336,753	B2	12/2012	Olson et al.
8,336,754	B2	12/2012	Cappola et al.
8,342,378	B2	1/2013	Marczyk et al.
8,342,379	B2	1/2013	Whitman et al.
8,348,123	B2	1/2013	Scirica et al.
8,348,126	B2	1/2013	Olson et al.
8,348,127	B2	1/2013	Marczyk
8,348,129	B2	1/2013	Bedi et al.
8,348,130	B2	1/2013	Shah et al.
8,348,131	B2	1/2013	Omaits et al.
8,353,437	B2	1/2013	Boudreaux
8,353,438	B2	1/2013	Baxter, III et al.
8,353,439	B2	1/2013	Baxter, III et al.
8,356,740	B1	1/2013	Knodel
8,360,296	B2	1/2013	Zingman
8,360,297	B2	1/2013	Shelton, IV et al.
8,360,298	B2	1/2013	Farascioni et al.
8,360,299	B2	1/2013	Zemlok et al.
8,365,973	B1	2/2013	White et al.
8,365,975	B1	2/2013	Manoux et al.
8,365,976	B2	2/2013	Hess et al.
8,371,491	B2	2/2013	Huitema et al.
8,371,492	B2	2/2013	Aranyi et al.
8,371,493	B2	2/2013	Aranyi et al.
8,377,029	B2	2/2013	Nagao et al.
8,393,513	B2	3/2013	Jankowski
8,393,514	B2	3/2013	Shelton, IV et al.
8,397,971	B2	3/2013	Yates et al.
8,398,633	B2	3/2013	Mueller
8,403,198	B2	3/2013	Sorrentino et al.
8,403,945	B2	3/2013	Whitfield et al.
8,408,439	B2	4/2013	Huang et al.
8,408,442	B2	4/2013	Racenet et al.
8,413,870	B2	4/2013	Pastorelli et al.
8,413,871	B2	4/2013	Racenet et al.
8,413,872	B2	4/2013	Patel
8,414,577	B2	4/2013	Boudreaux et al.
8,418,909	B2	4/2013	Kostrzewski
8,424,737	B2	4/2013	Scirica
8,424,739	B2	4/2013	Racenet et al.
8,424,740	B2	4/2013	Shelton, IV et al.
8,424,741	B2	4/2013	McGuckin, Jr. et al.
8,430,292	B2	4/2013	Patel et al.
8,439,246	B1	5/2013	Knodel

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,444,036	B2	5/2013	Shelton, IV
8,453,904	B2	6/2013	Eskaros et al.
8,453,906	B2	6/2013	Huang et al.
8,453,907	B2	6/2013	Laurent et al.
8,453,908	B2	6/2013	Bedi et al.
8,453,912	B2	6/2013	Mastri et al.
8,453,914	B2	6/2013	Laurent et al.
8,454,628	B2	6/2013	Smith et al.
8,459,520	B2	6/2013	Giordano et al.
8,459,525	B2	6/2013	Yates et al.
8,464,922	B2	6/2013	Marczyk
8,464,923	B2	6/2013	Shelton, IV
8,464,924	B2	6/2013	Gresham et al.
8,464,925	B2	6/2013	Hull et al.
8,469,973	B2	6/2013	Meade et al.
8,470,355	B2	6/2013	Skalla et al.
8,474,677	B2	7/2013	Woodard, Jr. et al.
8,475,454	B1	7/2013	Alshemari
8,479,969	B2	7/2013	Shelton, IV
8,480,703	B2	7/2013	Nicholas et al.
8,485,412	B2	7/2013	Shelton, IV et al.
8,485,413	B2	7/2013	Scheib et al.
8,490,853	B2	7/2013	Criscuolo et al.
8,496,156	B2	7/2013	Sniffin et al.
8,499,992	B2	8/2013	Whitman et al.
8,499,993	B2	8/2013	Shelton, IV et al.
8,506,555	B2	8/2013	Ruiz Morales
8,512,359	B2	8/2013	Whitman et al.
8,517,239	B2	8/2013	Scheib et al.
8,517,241	B2	8/2013	Nicholas et al.
8,517,243	B2	8/2013	Giordano et al.
8,517,244	B2	8/2013	Shelton, IV et al.
8,523,043	B2	9/2013	Ullrich et al.
8,529,600	B2	9/2013	Woodard, Jr. et al.
8,529,819	B2	9/2013	Ostapoff et al.
8,534,528	B2	9/2013	Shelton, IV
8,540,128	B2	9/2013	Shelton, IV et al.
8,540,129	B2	9/2013	Baxter, III et al.
8,540,130	B2	9/2013	Moore et al.
8,540,131	B2	9/2013	Swayze
8,540,133	B2	9/2013	Bedi et al.
8,550,984	B2	10/2013	Takemoto
8,556,151	B2	10/2013	Viola
8,561,870	B2	10/2013	Baxter, III et al.
8,561,873	B2	10/2013	Ingmanson et al.
8,567,656	B2	10/2013	Shelton, IV et al.
8,568,425	B2	10/2013	Ross et al.
8,573,459	B2	11/2013	Smith et al.
8,573,461	B2	11/2013	Shelton, IV et al.
8,573,465	B2	11/2013	Shelton, IV
8,579,176	B2	11/2013	Smith et al.
8,579,178	B2	11/2013	Holsten et al.
8,579,937	B2	11/2013	Gresham
8,584,919	B2	11/2013	Hueil et al.
8,590,760	B2	11/2013	Cummins et al.
8,590,762	B2	11/2013	Hess et al.
8,590,764	B2	11/2013	Hartwick et al.
8,596,513	B2	12/2013	Olson et al.
8,602,287	B2	12/2013	Yates et al.
8,602,288	B2	12/2013	Shelton, IV et al.
8,608,043	B2	12/2013	Scirica
8,608,044	B2	12/2013	Hueil et al.
8,608,045	B2	12/2013	Smith et al.
8,608,046	B2	12/2013	Laurent et al.
8,613,383	B2	12/2013	Beckman et al.
8,616,431	B2	12/2013	Timm et al.
8,622,274	B2	1/2014	Yates et al.
8,622,275	B2	1/2014	Baxter, III et al.
8,627,993	B2	1/2014	Smith et al.
8,627,995	B2	1/2014	Smith et al.
8,631,987	B2	1/2014	Shelton, IV et al.
8,631,993	B2	1/2014	Kostrzewski
8,632,462	B2	1/2014	Yoo et al.
8,632,525	B2	1/2014	Kerr et al.
8,632,535	B2	1/2014	Shelton, IV et al.
8,632,563	B2	1/2014	Nagase et al.
8,636,187	B2	1/2014	Hueil et al.
8,636,191	B2	1/2014	Meagher
8,636,736	B2	1/2014	Yates et al.
8,652,120	B2	2/2014	Giordano et al.
8,657,174	B2	2/2014	Yates et al.
8,657,176	B2	2/2014	Shelton, IV et al.
8,657,177	B2	2/2014	Scirica et al.
8,657,178	B2	2/2014	Hueil et al.
8,657,821	B2	2/2014	Palermo
8,662,370	B2	3/2014	Takei
8,668,129	B2	3/2014	Olson
8,668,130	B2	3/2014	Hess et al.
8,672,206	B2	3/2014	Aranyi et al.
8,672,207	B2	3/2014	Shelton, IV et al.
8,672,208	B2	3/2014	Hess et al.
8,672,951	B2	3/2014	Smith et al.
8,678,263	B2	3/2014	Viola
8,684,250	B2	4/2014	Bettuchi et al.
8,684,253	B2	4/2014	Giordano et al.
8,695,866	B2	4/2014	Leimbach et al.
8,701,958	B2	4/2014	Shelton, IV et al.
8,701,959	B2	4/2014	Shah
8,708,210	B2	4/2014	Zemlok et al.
8,708,211	B2	4/2014	Zemlok et al.
8,708,213	B2	4/2014	Shelton, IV et al.
8,720,766	B2	5/2014	Hess et al.
8,721,630	B2	5/2014	Ortiz et al.
8,727,197	B2	5/2014	Hess et al.
8,727,199	B2	5/2014	Wenchell
8,733,612	B2	5/2014	Ma
8,733,613	B2	5/2014	Huitema et al.
8,733,614	B2	5/2014	Ross et al.
8,734,478	B2	5/2014	Widenhouse et al.
8,740,034	B2	6/2014	Morgan et al.
8,740,037	B2	6/2014	Shelton, IV et al.
8,740,038	B2	6/2014	Shelton, IV et al.
8,746,529	B2	6/2014	Shelton, IV et al.
8,746,530	B2	6/2014	Giordano et al.
8,746,535	B2	6/2014	Shelton, IV et al.
8,747,238	B2	6/2014	Shelton, IV et al.
8,752,699	B2	6/2014	Morgan et al.
8,752,747	B2	6/2014	Shelton, IV et al.
8,752,749	B2	6/2014	Moore et al.
8,757,465	B2	6/2014	Woodard, Jr. et al.
8,758,391	B2	6/2014	Swayze et al.
8,763,875	B2	7/2014	Morgan et al.
8,763,877	B2	7/2014	Schall et al.
8,763,879	B2	7/2014	Shelton, IV et al.
8,770,458	B2	7/2014	Scirica
8,770,459	B2	7/2014	Racenet et al.
8,770,460	B2	7/2014	Belzer
8,777,004	B2	7/2014	Shelton, IV et al.
8,783,541	B2	7/2014	Shelton, IV et al.
8,783,542	B2	7/2014	Riestenberg et al.
8,783,543	B2	7/2014	Shelton, IV et al.
8,789,737	B2	7/2014	Hodgkinson et al.
8,789,739	B2	7/2014	Swensgard
8,789,740	B2	7/2014	Baxter, III et al.
8,789,741	B2	7/2014	Baxter, III et al.
8,794,496	B2	8/2014	Scirica
8,794,497	B2	8/2014	Zingman
8,795,308	B2	8/2014	Valin
8,800,837	B2	8/2014	Zemlok
8,800,838	B2	8/2014	Shelton, IV
8,800,840	B2	8/2014	Jankowski
8,800,841	B2	8/2014	Ellerhorst et al.
8,801,734	B2	8/2014	Shelton, IV et al.
8,801,735	B2	8/2014	Shelton, IV et al.
8,801,752	B2	8/2014	Fortier et al.
8,806,973	B2	8/2014	Ross et al.
8,807,414	B2	8/2014	Ross et al.
8,808,311	B2	8/2014	Heinrich et al.
8,808,325	B2	8/2014	Hess et al.
8,814,024	B2	8/2014	Woodard, Jr. et al.
8,814,025	B2	8/2014	Miller et al.
8,820,603	B2	9/2014	Shelton, IV et al.
8,820,605	B2	9/2014	Shelton, IV
8,820,606	B2	9/2014	Hodgkinson

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,827,133	B2	9/2014	Shelton, IV et al.
8,827,134	B2	9/2014	Viola et al.
8,827,903	B2	9/2014	Shelton, IV et al.
8,833,632	B2	9/2014	Swensgard
8,840,003	B2	9/2014	Morgan et al.
8,840,603	B2	9/2014	Shelton, IV et al.
8,844,789	B2	9/2014	Shelton, IV et al.
8,851,354	B2	10/2014	Swensgard et al.
8,857,693	B2	10/2014	Schuckmann et al.
8,857,694	B2	10/2014	Shelton, IV et al.
8,858,538	B2	10/2014	Belson et al.
8,858,571	B2	10/2014	Shelton, IV et al.
8,858,590	B2	10/2014	Shelton, IV et al.
8,864,007	B2	10/2014	Widenhouse et al.
8,864,009	B2	10/2014	Shelton, IV et al.
8,870,050	B2	10/2014	Hodgkinson
8,875,971	B2	11/2014	Hall et al.
8,875,972	B2	11/2014	Weisenburgh, II et al.
8,876,857	B2	11/2014	Burbank
8,893,946	B2	11/2014	Boudreaux et al.
8,893,949	B2	11/2014	Shelton, IV et al.
8,894,647	B2	11/2014	Beardsley et al.
8,899,463	B2	12/2014	Schall et al.
8,899,464	B2	12/2014	Hueil et al.
8,899,465	B2	12/2014	Shelton, IV et al.
8,899,466	B2	12/2014	Baxter, III et al.
8,905,977	B2	12/2014	Shelton et al.
8,911,471	B2	12/2014	Spivey et al.
8,920,433	B2	12/2014	Barrier et al.
8,920,435	B2	12/2014	Smith et al.
8,920,443	B2	12/2014	Hiles et al.
8,925,782	B2	1/2015	Shelton, IV
8,925,783	B2	1/2015	Zemlok et al.
8,925,788	B2	1/2015	Hess et al.
8,926,598	B2	1/2015	Mollere et al.
8,931,682	B2	1/2015	Timm et al.
8,939,343	B2	1/2015	Milliman et al.
8,939,344	B2	1/2015	Olson et al.
8,945,163	B2	2/2015	Voegele et al.
8,956,390	B2	2/2015	Shah et al.
8,960,520	B2	2/2015	McCuen
8,960,521	B2	2/2015	Kostrzewski
8,967,443	B2	3/2015	McCuen
8,967,446	B2	3/2015	Beardsley et al.
8,967,448	B2	3/2015	Carter et al.
8,973,803	B2	3/2015	Hall et al.
8,973,804	B2	3/2015	Hess et al.
8,974,440	B2	3/2015	Farritor et al.
8,978,954	B2	3/2015	Shelton, IV et al.
8,978,955	B2	3/2015	Aronhalt et al.
8,978,956	B2	3/2015	Schall et al.
8,985,428	B2	3/2015	Natarajan et al.
8,991,676	B2	3/2015	Hess et al.
8,991,677	B2	3/2015	Moore et al.
8,992,422	B2	3/2015	Spivey et al.
8,998,058	B2	4/2015	Moore et al.
8,998,059	B2	4/2015	Smith et al.
9,005,230	B2	4/2015	Yates et al.
9,005,238	B2	4/2015	DeSantis et al.
9,010,608	B2	4/2015	Casasanta, Jr. et al.
9,016,541	B2	4/2015	Viola et al.
9,016,542	B2	4/2015	Shelton, IV et al.
9,028,494	B2	5/2015	Shelton, IV et al.
9,028,495	B2	5/2015	Mueller et al.
9,028,519	B2	5/2015	Yates et al.
9,033,203	B2	5/2015	Woodard, Jr. et al.
9,033,204	B2	5/2015	Shelton, IV et al.
9,038,881	B1	5/2015	Schaller et al.
9,044,227	B2	6/2015	Shelton, IV et al.
9,044,228	B2	6/2015	Woodard, Jr. et al.
9,044,229	B2	6/2015	Scheib et al.
9,044,230	B2	6/2015	Morgan et al.
9,050,083	B2	6/2015	Yates et al.
9,050,084	B2	6/2015	Schmid et al.
9,055,941	B2	6/2015	Schmid et al.
9,055,944	B2	6/2015	Hodgkinson et al.
9,060,770	B2	6/2015	Shelton, IV et al.
9,060,894	B2	6/2015	Wubbeling
9,072,515	B2	7/2015	Hall et al.
9,072,535	B2	7/2015	Shelton, IV et al.
9,072,536	B2	7/2015	Shelton, IV et al.
9,078,653	B2	7/2015	Leimbach et al.
9,084,601	B2	7/2015	Moore et al.
9,084,602	B2	7/2015	Gleiman
9,089,326	B2	7/2015	Krumanaker et al.
9,089,330	B2	7/2015	Widenhouse et al.
9,089,352	B2	7/2015	Jeong
9,095,339	B2	8/2015	Moore et al.
9,095,362	B2	8/2015	Dachs, II et al.
9,101,358	B2	8/2015	Kerr et al.
9,101,385	B2	8/2015	Shelton, IV et al.
9,107,663	B2	8/2015	Swensgard
9,113,862	B2	8/2015	Morgan et al.
9,113,864	B2	8/2015	Morgan et al.
9,113,865	B2	8/2015	Shelton, IV et al.
9,113,874	B2	8/2015	Shelton, IV et al.
9,113,880	B2	8/2015	Zemlok et al.
9,113,883	B2	8/2015	Aronhalt et al.
9,113,884	B2	8/2015	Shelton, IV et al.
9,119,957	B2	9/2015	Gantz et al.
9,125,654	B2	9/2015	Aronhalt et al.
9,125,662	B2	9/2015	Shelton, IV
9,131,940	B2	9/2015	Huitema et al.
9,138,225	B2	9/2015	Huang et al.
9,149,274	B2	10/2015	Spivey et al.
9,168,038	B2	10/2015	Shelton, IV et al.
9,179,911	B2	11/2015	Morgan et al.
9,179,912	B2	11/2015	Yates et al.
9,186,143	B2	11/2015	Timm et al.
9,192,380	B2	11/2015	(Tarinelli) Racenet et al.
9,192,384	B2	11/2015	Bettuchi
9,198,661	B2	12/2015	Swensgard
9,198,662	B2	12/2015	Barton et al.
9,204,877	B2	12/2015	Whitman et al.
9,204,878	B2	12/2015	Hall et al.
9,204,879	B2	12/2015	Shelton, IV
9,204,880	B2	12/2015	Baxter, III et al.
9,211,120	B2	12/2015	Scheib et al.
9,211,121	B2	12/2015	Hall et al.
9,211,122	B2	12/2015	Hagerty et al.
9,216,019	B2	12/2015	Schmid et al.
9,220,500	B2	12/2015	Swayze et al.
9,220,501	B2	12/2015	Baxter, III et al.
9,220,502	B2	12/2015	Zemlok et al.
9,220,559	B2	12/2015	Worrell et al.
9,226,751	B2	1/2016	Shelton, IV et al.
9,232,941	B2	1/2016	Mandakolathur Vasudevan et al.
9,232,945	B2	1/2016	Zingman
9,237,891	B2	1/2016	Shelton, IV
9,241,714	B2	1/2016	Timm et al.
9,271,799	B2	3/2016	Shelton, IV et al.
9,272,406	B2	3/2016	Aronhalt et al.
9,277,919	B2	3/2016	Timmer et al.
9,282,962	B2	3/2016	Schmid et al.
9,282,966	B2	3/2016	Shelton, IV et al.
9,282,974	B2	3/2016	Shelton, IV
9,283,054	B2	3/2016	Morgan et al.
9,289,206	B2	3/2016	Hess et al.
9,289,210	B2	3/2016	Baxter, III et al.
9,289,212	B2	3/2016	Shelton, IV et al.
9,289,225	B2	3/2016	Shelton, IV et al.
9,289,256	B2	3/2016	Shelton, IV et al.
9,295,464	B2	3/2016	Shelton, IV et al.
9,295,466	B2	3/2016	Hodgkinson et al.
9,295,784	B2	3/2016	Eggert et al.
9,301,752	B2	4/2016	Mandakolathur Vasudevan et al.
9,301,753	B2	4/2016	Aldridge et al.
9,301,755	B2	4/2016	Shelton, IV et al.
9,301,759	B2	4/2016	Spivey et al.
9,307,965	B2	4/2016	Ming et al.
9,307,986	B2	4/2016	Hall et al.
9,307,987	B2	4/2016	Swensgard et al.
9,307,988	B2	4/2016	Shelton, IV
9,307,989	B2	4/2016	Shelton, IV et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,307,994	B2	4/2016	Gresham et al.
9,314,246	B2	4/2016	Shelton, IV et al.
9,314,247	B2	4/2016	Shelton, IV et al.
9,320,518	B2	4/2016	Henderson et al.
9,320,520	B2	4/2016	Shelton, IV et al.
9,320,521	B2	4/2016	Shelton, IV et al.
9,320,523	B2	4/2016	Shelton, IV et al.
9,326,767	B2	5/2016	Koch et al.
9,326,768	B2	5/2016	Shelton, IV
9,326,769	B2	5/2016	Shelton, IV et al.
9,326,770	B2	5/2016	Shelton, IV et al.
9,326,771	B2	5/2016	Baxter, III et al.
9,332,974	B2	5/2016	Henderson et al.
9,332,984	B2	5/2016	Weaner et al.
9,332,987	B2	5/2016	Leimbach et al.
9,345,477	B2	5/2016	Anim et al.
9,345,481	B2	5/2016	Hall et al.
9,351,726	B2	5/2016	Leimbach et al.
9,351,727	B2	5/2016	Leimbach et al.
9,351,730	B2	5/2016	Schmid et al.
9,351,731	B2	5/2016	Carter et al.
9,358,003	B2	6/2016	Hall et al.
9,358,005	B2	6/2016	Shelton, IV et al.
9,364,219	B2	6/2016	Olson et al.
9,364,229	B2	6/2016	D'Agostino et al.
9,364,230	B2	6/2016	Shelton, IV et al.
9,364,233	B2	6/2016	Alexander, III et al.
9,370,358	B2	6/2016	Shelton, IV et al.
9,370,364	B2	6/2016	Smith et al.
9,386,983	B2	7/2016	Swensgard et al.
9,386,984	B2	7/2016	Aronhalt et al.
9,386,985	B2	7/2016	Koch, Jr. et al.
9,386,988	B2	7/2016	Baxter, III et al.
9,393,015	B2	7/2016	Laurent et al.
9,393,018	B2	7/2016	Wang et al.
9,398,911	B2	7/2016	Auld
9,402,626	B2	8/2016	Ortiz et al.
9,408,604	B2	8/2016	Shelton, IV et al.
9,408,606	B2	8/2016	Shelton, IV
9,414,838	B2	8/2016	Shelton, IV et al.
9,421,014	B2	8/2016	Ingmanson et al.
9,421,060	B2	8/2016	Monson et al.
9,427,223	B2	8/2016	Park et al.
9,433,411	B2	9/2016	Racenet et al.
9,433,419	B2	9/2016	Gonzalez et al.
9,433,420	B2	9/2016	Hodgkinson
9,439,649	B2	9/2016	Shelton, IV et al.
9,439,651	B2	9/2016	Smith et al.
9,445,813	B2	9/2016	Shelton, IV et al.
9,451,958	B2	9/2016	Shelton, IV et al.
9,468,438	B2	10/2016	Baber et al.
9,480,476	B2	11/2016	Aldridge et al.
9,486,213	B2	11/2016	Altman et al.
9,486,214	B2	11/2016	Shelton, IV
9,486,302	B2	11/2016	Boey et al.
9,492,167	B2	11/2016	Shelton, IV et al.
9,492,170	B2	11/2016	Bear et al.
9,498,219	B2	11/2016	Moore et al.
9,510,828	B2	12/2016	Yates et al.
9,510,830	B2	12/2016	Shelton, IV et al.
9,510,925	B2	12/2016	Hotter et al.
9,517,063	B2	12/2016	Swayze et al.
9,517,068	B2	12/2016	Shelton, IV et al.
9,522,029	B2	12/2016	Yates et al.
9,549,732	B2	1/2017	Yates et al.
9,549,735	B2	1/2017	Shelton, IV et al.
9,554,794	B2	1/2017	Baber et al.
9,561,032	B2	2/2017	Shelton, IV et al.
9,561,038	B2	2/2017	Shelton, IV et al.
9,566,061	B2	2/2017	Aronhalt et al.
9,572,574	B2	2/2017	Shelton, IV et al.
9,572,577	B2	2/2017	Lloyd et al.
9,574,644	B2	2/2017	Parihar
9,585,657	B2	3/2017	Shelton, IV et al.
9,585,660	B2	3/2017	Laurent et al.
9,585,662	B2	3/2017	Shelton, IV et al.
9,592,050	B2	3/2017	Schmid et al.
9,592,052	B2	3/2017	Shelton, IV
9,592,053	B2	3/2017	Shelton, IV et al.
9,592,054	B2	3/2017	Schmid et al.
9,597,075	B2	3/2017	Shelton, IV et al.
9,597,080	B2	3/2017	Milliman et al.
9,603,595	B2	3/2017	Shelton, IV et al.
9,603,598	B2	3/2017	Shelton, IV et al.
9,603,991	B2	3/2017	Shelton, IV et al.
9,615,826	B2	4/2017	Shelton, IV et al.
9,629,623	B2	4/2017	Lytle, IV et al.
9,629,626	B2	4/2017	Soltz et al.
9,629,629	B2	4/2017	Leimbach et al.
9,629,814	B2	4/2017	Widenhouse et al.
9,642,620	B2	5/2017	Baxter, III et al.
9,649,096	B2	5/2017	Sholev
9,649,110	B2	5/2017	Parihar et al.
9,649,111	B2	5/2017	Shelton, IV et al.
9,655,614	B2	5/2017	Swensgard et al.
9,655,615	B2	5/2017	Knodel et al.
9,655,624	B2	5/2017	Shelton, IV et al.
9,662,110	B2	5/2017	Huang et al.
9,668,732	B2	6/2017	Patel et al.
9,675,351	B2	6/2017	Hodgkinson et al.
9,675,355	B2	6/2017	Shelton, IV et al.
9,675,372	B2	6/2017	Laurent et al.
9,675,375	B2	6/2017	Houser et al.
9,681,870	B2	6/2017	Baxter, III et al.
9,681,873	B2	6/2017	Smith et al.
9,687,230	B2	6/2017	Leimbach et al.
9,687,231	B2	6/2017	Baxter, III et al.
9,687,232	B2	6/2017	Shelton, IV et al.
9,687,236	B2	6/2017	Leimbach et al.
9,687,237	B2	6/2017	Schmid et al.
9,690,362	B2	6/2017	Leimbach et al.
9,693,772	B2	7/2017	Ingmanson et al.
9,693,777	B2	7/2017	Schellin et al.
9,693,819	B2	7/2017	Francischelli et al.
9,700,309	B2	7/2017	Jaworek et al.
9,700,310	B2	7/2017	Morgan et al.
9,700,317	B2	7/2017	Aronhalt et al.
9,700,319	B2	7/2017	Motooka et al.
9,700,321	B2	7/2017	Shelton, IV et al.
9,706,991	B2	7/2017	Hess et al.
9,724,091	B2	8/2017	Shelton, IV et al.
9,724,092	B2	8/2017	Baxter, III et al.
9,724,094	B2	8/2017	Baber et al.
9,724,098	B2	8/2017	Baxter, III et al.
9,730,692	B2	8/2017	Shelton, IV et al.
9,730,695	B2	8/2017	Leimbach et al.
9,730,697	B2	8/2017	Morgan et al.
9,733,663	B2	8/2017	Leimbach et al.
9,737,301	B2	8/2017	Baber et al.
9,737,303	B2	8/2017	Shelton, IV et al.
9,743,928	B2	8/2017	Shelton, IV et al.
9,743,929	B2	8/2017	Leimbach et al.
9,750,498	B2	9/2017	Timm et al.
9,750,499	B2	9/2017	Leimbach et al.
9,757,123	B2	9/2017	Giordano et al.
9,757,124	B2	9/2017	Schellin et al.
9,757,128	B2	9/2017	Baber et al.
9,757,130	B2	9/2017	Shelton, IV
9,763,662	B2	9/2017	Shelton, IV et al.
9,770,245	B2	9/2017	Swayze et al.
9,775,608	B2	10/2017	Aronhalt et al.
9,775,609	B2	10/2017	Shelton, IV et al.
9,775,613	B2	10/2017	Shelton, IV et al.
9,775,614	B2	10/2017	Shelton, IV et al.
9,782,169	B2	10/2017	Kimsey et al.
9,788,834	B2	10/2017	Schmid et al.
9,788,836	B2	10/2017	Overmyer et al.
9,795,382	B2	10/2017	Shelton, IV
9,795,384	B2	10/2017	Weaner et al.
9,801,626	B2	10/2017	Parihar et al.
9,801,627	B2	10/2017	Harris et al.
9,801,628	B2	10/2017	Harris et al.
9,801,634	B2	10/2017	Shelton, IV et al.
9,804,618	B2	10/2017	Leimbach et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,808,244	B2	11/2017	Leimbach et al.
9,808,247	B2	11/2017	Shelton, IV et al.
9,808,249	B2	11/2017	Shelton, IV
9,814,460	B2	11/2017	Kimsey et al.
9,814,462	B2	11/2017	Woodard, Jr. et al.
9,820,738	B2	11/2017	Lytle, IV et al.
9,820,741	B2	11/2017	Kostrzewski
9,826,976	B2	11/2017	Parihar et al.
9,826,977	B2	11/2017	Leimbach et al.
9,826,978	B2	11/2017	Shelton, IV et al.
9,833,236	B2	12/2017	Shelton, IV et al.
9,833,241	B2	12/2017	Huitema et al.
9,839,420	B2	12/2017	Shelton, IV et al.
9,839,421	B2	12/2017	Zerkle et al.
9,839,422	B2	12/2017	Schellin et al.
9,839,423	B2	12/2017	Vendely et al.
9,839,427	B2	12/2017	Swayze et al.
9,839,428	B2	12/2017	Baxter, III et al.
9,839,429	B2	12/2017	Weisenburgh, II et al.
9,844,368	B2	12/2017	Boudreaux et al.
9,844,369	B2	12/2017	Huitema et al.
9,844,372	B2	12/2017	Shelton, IV et al.
9,844,373	B2	12/2017	Swayze et al.
9,844,376	B2	12/2017	Baxter, III et al.
9,848,873	B2	12/2017	Shelton, IV
9,848,875	B2	12/2017	Aronhalt et al.
9,861,359	B2	1/2018	Shelton, IV et al.
9,861,361	B2	1/2018	Aronhalt et al.
9,867,612	B2	1/2018	Parihar et al.
9,867,618	B2	1/2018	Hall et al.
9,872,684	B2	1/2018	Hall et al.
9,877,721	B2	1/2018	Schellin et al.
9,883,860	B2	2/2018	Leimbach
9,883,861	B2	2/2018	Shelton, IV et al.
9,884,456	B2	2/2018	Schellin et al.
9,888,919	B2	2/2018	Leimbach et al.
9,888,924	B2	2/2018	Ebersole et al.
9,895,147	B2	2/2018	Shelton, IV
9,913,642	B2	3/2018	Leimbach et al.
9,913,647	B2	3/2018	Weisenburgh, II et al.
9,918,704	B2	3/2018	Shelton, IV et al.
9,918,716	B2	3/2018	Baxter, III et al.
9,924,942	B2	3/2018	Swayze et al.
9,924,944	B2	3/2018	Shelton, IV et al.
9,924,947	B2	3/2018	Shelton, IV et al.
9,943,310	B2	4/2018	Harris et al.
9,962,158	B2	5/2018	Hall et al.
9,962,161	B2	5/2018	Scheib et al.
9,968,354	B2	5/2018	Shelton, IV et al.
9,968,356	B2	5/2018	Shelton, IV et al.
9,974,529	B2	5/2018	Shelton, IV et al.
9,974,538	B2	5/2018	Baxter, III et al.
9,980,713	B2	5/2018	Aronhalt et al.
9,987,006	B2	6/2018	Morgan et al.
9,999,408	B2	6/2018	Boudreaux et al.
10,004,497	B2	6/2018	Overmyer et al.
10,004,498	B2	6/2018	Morgan et al.
10,010,322	B2	7/2018	Shelton, IV et al.
10,010,324	B2	7/2018	Huitema et al.
10,013,049	B2	7/2018	Leimbach et al.
10,016,199	B2	7/2018	Baber et al.
10,028,742	B2	7/2018	Shelton, IV et al.
10,028,743	B2	7/2018	Shelton, IV et al.
10,028,761	B2	7/2018	Leimbach et al.
10,039,529	B2	8/2018	Kerr et al.
10,045,769	B2	8/2018	Aronhalt et al.
10,045,781	B2	8/2018	Cropper et al.
10,052,099	B2	8/2018	Morgan et al.
10,052,100	B2	8/2018	Morgan et al.
10,052,104	B2	8/2018	Shelton, IV et al.
10,058,327	B2	8/2018	Weisenburgh, II et al.
10,058,963	B2	8/2018	Shelton, IV et al.
10,064,621	B2	9/2018	Kerr et al.
10,064,624	B2	9/2018	Shelton, IV et al.
10,070,861	B2	9/2018	Spivey et al.
10,070,863	B2	9/2018	Swayze et al.
10,071,452	B2	9/2018	Shelton, IV et al.
10,076,325	B2	9/2018	Huang et al.
10,085,806	B2	10/2018	Hagn et al.
10,111,679	B2	10/2018	Baber et al.
10,123,798	B2	11/2018	Baxter, III et al.
10,130,352	B2	11/2018	Widenhouse et al.
10,130,359	B2	11/2018	Hess et al.
10,130,363	B2	11/2018	Huitema et al.
10,130,366	B2	11/2018	Shelton, IV et al.
10,135,242	B2	11/2018	Baber et al.
10,136,887	B2	11/2018	Shelton, IV et al.
10,136,890	B2	11/2018	Shelton, IV et al.
10,149,679	B2	12/2018	Shelton, IV et al.
10,149,680	B2	12/2018	Parihar et al.
10,149,682	B2	12/2018	Shelton, IV et al.
10,159,482	B2	12/2018	Swayze et al.
10,166,025	B2	1/2019	Leimbach et al.
10,172,616	B2	1/2019	Murray et al.
10,182,819	B2	1/2019	Shelton, IV
10,188,393	B2	1/2019	Smith et al.
10,194,910	B2	2/2019	Shelton, IV et al.
10,201,364	B2	2/2019	Leimbach et al.
10,206,677	B2	2/2019	Harris et al.
10,206,678	B2	2/2019	Shelton, IV et al.
10,213,198	B2	2/2019	Aronhalt et al.
10,238,385	B2	3/2019	Yates et al.
10,238,387	B2	3/2019	Yates et al.
10,245,035	B2	4/2019	Swayze et al.
10,258,330	B2	4/2019	Shelton, IV et al.
10,258,333	B2	4/2019	Shelton, IV et al.
10,265,065	B2	4/2019	Shelton, IV et al.
10,265,067	B2	4/2019	Yates et al.
10,265,072	B2	4/2019	Shelton, IV et al.
10,271,845	B2	4/2019	Shelton, IV
10,299,792	B2	5/2019	Huitema et al.
10,327,764	B2	6/2019	Harris et al.
10,327,776	B2	6/2019	Harris et al.
10,335,144	B2	7/2019	Shelton, IV et al.
10,335,148	B2	7/2019	Shelton, IV et al.
10,335,150	B2	7/2019	Shelton, IV
10,342,533	B2	7/2019	Shelton, IV et al.
10,342,541	B2	7/2019	Shelton, IV et al.
10,383,629	B2	8/2019	Ross et al.
10,390,823	B2	8/2019	Shelton, IV et al.
10,398,433	B2	9/2019	Boudreaux et al.
10,398,436	B2	9/2019	Shelton, IV et al.
10,405,854	B2	9/2019	Schmid et al.
10,405,857	B2	9/2019	Shelton, IV et al.
10,426,476	B2	10/2019	Harris et al.
10,426,477	B2	10/2019	Harris et al.
10,426,478	B2	10/2019	Shelton, IV et al.
10,433,918	B2	10/2019	Shelton, IV et al.
10,441,285	B2	10/2019	Shelton, IV et al.
10,441,369	B2	10/2019	Shelton, IV et al.
10,456,133	B2	10/2019	Yates et al.
10,470,762	B2	11/2019	Leimbach et al.
10,470,763	B2	11/2019	Yates et al.
10,470,768	B2	11/2019	Harris et al.
10,485,536	B2	11/2019	Ming et al.
10,492,787	B2	12/2019	Smith et al.
10,517,594	B2	12/2019	Shelton, IV et al.
10,517,682	B2	12/2019	Giordano et al.
2002/0117534	A1	8/2002	Green et al.
2002/0143346	A1*	10/2002	McGuckin, Jr. A61B 17/07207 606/139
2003/0009193	A1	1/2003	Corsaro
2003/0039689	A1	2/2003	Chen et al.
2003/0096158	A1	5/2003	Takano et al.
2003/0181900	A1	9/2003	Long
2003/0236505	A1	12/2003	Bonadio et al.
2004/0068161	A1	4/2004	Couvillon
2004/0068224	A1	4/2004	Couvillon et al.
2004/0102783	A1	5/2004	Sutterlin et al.
2004/0108357	A1	6/2004	Milliman et al.
2004/0147909	A1	7/2004	Johnston et al.
2004/0164123	A1	8/2004	Racenet et al.
2004/0199181	A1	10/2004	Knodel et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2004/0222268	A1	11/2004	Bilotti et al.
2004/0225186	A1	11/2004	Horne et al.
2004/0232201	A1	11/2004	Wenchell et al.
2005/0054946	A1	3/2005	Krzyzanowski
2005/0070929	A1	3/2005	Dalessandro et al.
2005/0080342	A1	4/2005	Gilreath et al.
2005/0125897	A1	6/2005	Wyslucha et al.
2005/0139636	A1	6/2005	Schwemberger et al.
2005/0143759	A1	6/2005	Kelly
2005/0184121	A1	8/2005	Heinrich
2005/0228224	A1	10/2005	Okada et al.
2005/0263563	A1	12/2005	Racenet et al.
2006/0049229	A1	3/2006	Milliman et al.
2006/0089535	A1	4/2006	Raz et al.
2006/0173470	A1	8/2006	Oray et al.
2006/0180634	A1	8/2006	Shelton et al.
2006/0201989	A1	9/2006	Ojeda
2006/0235368	A1	10/2006	Oz
2006/0271102	A1	11/2006	Bosshard et al.
2006/0287576	A1	12/2006	Tsuji et al.
2006/0289602	A1	12/2006	Wales et al.
2006/0291981	A1	12/2006	Viola et al.
2007/0027468	A1	2/2007	Wales et al.
2007/0051375	A1	3/2007	Milliman
2007/0084897	A1	4/2007	Shelton et al.
2007/0093869	A1	4/2007	Bloom et al.
2007/0102472	A1	5/2007	Shelton
2007/0106317	A1	5/2007	Shelton et al.
2007/0134251	A1	6/2007	Ashkenazi et al.
2007/0170225	A1	7/2007	Shelton et al.
2007/0173687	A1	7/2007	Shima et al.
2007/0175950	A1	8/2007	Shelton et al.
2007/0175951	A1	8/2007	Shelton et al.
2007/0175955	A1	8/2007	Shelton et al.
2007/0194079	A1	8/2007	Hueil et al.
2007/0194082	A1	8/2007	Morgan et al.
2007/0203510	A1	8/2007	Bettuchi
2007/0225562	A1	9/2007	Spivey et al.
2007/0233163	A1	10/2007	Bombard et al.
2007/0246505	A1	10/2007	Pace-Floridia et al.
2007/0276409	A1	11/2007	Ortiz et al.
2007/0279011	A1	12/2007	Jones et al.
2008/0029570	A1	2/2008	Shelton et al.
2008/0029573	A1	2/2008	Shelton et al.
2008/0029574	A1	2/2008	Shelton et al.
2008/0029575	A1	2/2008	Shelton et al.
2008/0078802	A1	4/2008	Hess et al.
2008/0082125	A1	4/2008	Murray et al.
2008/0082126	A1	4/2008	Murray et al.
2008/0086078	A1	4/2008	Powell et al.
2008/0091072	A1	4/2008	Omori et al.
2008/0108443	A1	5/2008	Jinno et al.
2008/0135600	A1	6/2008	Hiranuma et al.
2008/0140115	A1	6/2008	Stopek
2008/0169328	A1	7/2008	Shelton
2008/0169332	A1	7/2008	Shelton et al.
2008/0169333	A1	7/2008	Shelton et al.
2008/0172087	A1	7/2008	Fuchs et al.
2008/0190989	A1	8/2008	Crews et al.
2008/0197167	A1	8/2008	Viola et al.
2008/0200762	A1	8/2008	Stokes et al.
2008/0249536	A1	10/2008	Stahler et al.
2008/0296346	A1	12/2008	Shelton, IV et al.
2008/0308602	A1	12/2008	Timm et al.
2008/0308603	A1	12/2008	Shelton et al.
2008/0315829	A1	12/2008	Jones et al.
2009/0001121	A1	1/2009	Hess et al.
2009/0001130	A1	1/2009	Hess et al.
2009/0005809	A1	1/2009	Hess et al.
2009/0048589	A1	2/2009	Takashino et al.
2009/0078736	A1	3/2009	Van Lue
2009/0090763	A1	4/2009	Zemlok et al.
2009/0099876	A1	4/2009	Whitman
2009/0149871	A9	6/2009	Kagan et al.
2009/0188964	A1	7/2009	Orlov
2009/0204108	A1	8/2009	Steffen
2009/0206125	A1	8/2009	Huitema et al.
2009/0206126	A1	8/2009	Huitema et al.
2009/0206131	A1	8/2009	Weisenburgh, II et al.
2009/0206133	A1	8/2009	Morgan et al.
2009/0206137	A1	8/2009	Hall et al.
2009/0206139	A1	8/2009	Hall et al.
2009/0206141	A1	8/2009	Huitema et al.
2009/0206142	A1	8/2009	Huitema et al.
2009/0242610	A1	10/2009	Shelton, IV et al.
2009/0255974	A1	10/2009	Viola
2009/0308907	A1	12/2009	Nalagatla et al.
2010/0069942	A1	3/2010	Shelton, IV
2010/0133317	A1	6/2010	Shelton, IV et al.
2010/0147921	A1	6/2010	Olson
2010/0147922	A1	6/2010	Olson
2010/0193566	A1	8/2010	Scheib et al.
2010/0222901	A1	9/2010	Swayze et al.
2011/0006101	A1	1/2011	Hall et al.
2011/0011916	A1	1/2011	Levine
2011/0024477	A1	2/2011	Hall
2011/0024478	A1	2/2011	Shelton, IV
2011/0036891	A1	2/2011	Zemlok et al.
2011/0060363	A1	3/2011	Hess et al.
2011/0087276	A1	4/2011	Bedi et al.
2011/0091515	A1	4/2011	Zilberman et al.
2011/0114697	A1	5/2011	Baxter, III et al.
2011/0125176	A1	5/2011	Yates et al.
2011/0147433	A1	6/2011	Shelton, IV et al.
2011/0163146	A1	7/2011	Ortiz et al.
2011/0174861	A1	7/2011	Shelton, IV et al.
2011/0192882	A1	8/2011	Hess et al.
2011/0275901	A1	11/2011	Shelton, IV
2011/0276083	A1	11/2011	Shelton, IV et al.
2011/0278343	A1	11/2011	Knodel et al.
2011/0290856	A1	12/2011	Shelton, IV et al.
2011/0293690	A1	12/2011	Griffin et al.
2011/0295295	A1	12/2011	Shelton, IV et al.
2012/0029272	A1	2/2012	Shelton, IV et al.
2012/0074200	A1	3/2012	Schmid et al.
2012/0080336	A1	4/2012	Shelton, IV et al.
2012/0080344	A1	4/2012	Shelton, IV
2012/0080478	A1	4/2012	Morgan et al.
2012/0080498	A1	4/2012	Shelton, IV et al.
2012/0109186	A1	5/2012	Parrott et al.
2012/0125792	A1	5/2012	Cassivi
2012/0175398	A1	7/2012	Sandborn et al.
2012/0234895	A1	9/2012	O'Connor et al.
2012/0234897	A1	9/2012	Shelton, IV et al.
2012/0248169	A1	10/2012	Widenhouse et al.
2012/0283707	A1	11/2012	Giordano et al.
2012/0292367	A1	11/2012	Morgan et al.
2012/0298722	A1	11/2012	Hess et al.
2012/0303002	A1	11/2012	Chowaniec et al.
2013/0006227	A1	1/2013	Takashino
2013/0020375	A1	1/2013	Shelton, IV et al.
2013/0020376	A1	1/2013	Shelton, IV et al.
2013/0023861	A1	1/2013	Shelton, IV et al.
2013/0026208	A1	1/2013	Shelton, IV et al.
2013/0026210	A1	1/2013	Shelton, IV et al.
2013/0087597	A1	4/2013	Shelton, IV et al.
2013/0098970	A1	4/2013	Racenet et al.
2013/0116669	A1	5/2013	Shelton, IV et al.
2013/0153641	A1	6/2013	Shelton, IV et al.
2013/0175317	A1	7/2013	Yates et al.
2013/0214025	A1	8/2013	Zemlok et al.
2013/0233906	A1	9/2013	Hess et al.
2013/0256373	A1	10/2013	Schmid et al.
2013/0256380	A1	10/2013	Schmid et al.
2013/0270322	A1	10/2013	Scheib et al.
2013/0334283	A1	12/2013	Swayze et al.
2013/0334285	A1	12/2013	Swayze et al.
2013/0341374	A1	12/2013	Shelton, IV et al.
2014/0001231	A1	1/2014	Shelton, IV et al.
2014/0001234	A1	1/2014	Shelton, IV et al.
2014/0005640	A1	1/2014	Shelton, IV et al.
2014/0005678	A1	1/2014	Shelton, IV et al.
2014/0005718	A1	1/2014	Shelton, IV et al.
2014/0012299	A1	1/2014	Stoddard et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2014/0014705	A1	1/2014	Baxter, III
2014/0039549	A1	2/2014	Belsky et al.
2014/0048580	A1	2/2014	Merchant et al.
2014/0107640	A1	4/2014	Yates et al.
2014/0151433	A1	6/2014	Shelton, IV et al.
2014/0166724	A1	6/2014	Schellin et al.
2014/0166725	A1	6/2014	Schellin et al.
2014/0166726	A1	6/2014	Schellin et al.
2014/0175152	A1	6/2014	Hess et al.
2014/0188159	A1	7/2014	Steege
2014/0224857	A1	8/2014	Schmid
2014/0243865	A1	8/2014	Swayze et al.
2014/0246475	A1	9/2014	Hall et al.
2014/0249557	A1	9/2014	Koch et al.
2014/0263541	A1	9/2014	Leimbach et al.
2014/0263552	A1	9/2014	Hall et al.
2014/0263558	A1	9/2014	Hausen et al.
2014/0284371	A1	9/2014	Morgan et al.
2014/0291379	A1	10/2014	Schellin et al.
2014/0291383	A1	10/2014	Spivey et al.
2014/0299648	A1	10/2014	Shelton, IV et al.
2014/0303645	A1	10/2014	Morgan et al.
2014/0330161	A1	11/2014	Swayze et al.
2015/0008248	A1	1/2015	Giordano et al.
2015/0053737	A1	2/2015	Leimbach et al.
2015/0053742	A1	2/2015	Shelton, IV et al.
2015/0053743	A1	2/2015	Yates et al.
2015/0053746	A1	2/2015	Shelton, IV et al.
2015/0053748	A1	2/2015	Yates et al.
2015/0060518	A1	3/2015	Shelton, IV et al.
2015/0060519	A1	3/2015	Shelton, IV et al.
2015/0060520	A1	3/2015	Shelton, IV et al.
2015/0060521	A1	3/2015	Weisenburgh, II et al.
2015/0076208	A1	3/2015	Shelton, IV
2015/0076209	A1	3/2015	Shelton, IV et al.
2015/0076210	A1	3/2015	Shelton, IV et al.
2015/0076212	A1	3/2015	Shelton, IV
2015/0080868	A1	3/2015	Kerr
2015/0083781	A1	3/2015	Giordano et al.
2015/0083782	A1	3/2015	Scheib et al.
2015/0090760	A1	4/2015	Giordano et al.
2015/0090762	A1	4/2015	Giordano et al.
2015/0173749	A1	6/2015	Shelton, IV et al.
2015/0173756	A1	6/2015	Baxter, III et al.
2015/0173789	A1	6/2015	Baxter, III et al.
2015/0196295	A1	7/2015	Shelton, IV et al.
2015/0196296	A1	7/2015	Swayze et al.
2015/0196299	A1	7/2015	Swayze et al.
2015/0201932	A1	7/2015	Swayze et al.
2015/0201936	A1	7/2015	Swayze et al.
2015/0201937	A1	7/2015	Swayze et al.
2015/0201938	A1	7/2015	Swayze et al.
2015/0201939	A1	7/2015	Swayze et al.
2015/0201940	A1	7/2015	Swayze et al.
2015/0201941	A1	7/2015	Swayze et al.
2015/0231409	A1	8/2015	Racenet et al.
2015/0272557	A1	10/2015	Overmyer et al.
2015/0272571	A1	10/2015	Leimbach et al.
2015/0272580	A1	10/2015	Leimbach et al.
2015/0272582	A1	10/2015	Leimbach et al.
2015/0297222	A1	10/2015	Huitema et al.
2015/0297223	A1	10/2015	Huitema et al.
2015/0297225	A1	10/2015	Huitema et al.
2015/0297228	A1	10/2015	Huitema et al.
2015/0297229	A1	10/2015	Schellin et al.
2015/0297233	A1	10/2015	Huitema et al.
2015/0297234	A1	10/2015	Schellin et al.
2015/0313594	A1	11/2015	Shelton, IV et al.
2015/0374369	A1	12/2015	Yates et al.
2015/0374378	A1	12/2015	Giordano et al.
2016/0000431	A1	1/2016	Giordano et al.
2016/0000437	A1	1/2016	Giordano et al.
2016/0000438	A1	1/2016	Swayze et al.
2016/0000442	A1	1/2016	Shelton, IV
2016/0000452	A1	1/2016	Yates et al.
2016/0000453	A1	1/2016	Yates et al.
2016/0058443	A1	3/2016	Yates et al.
2016/0066913	A1	3/2016	Swayze et al.
2016/0074040	A1	3/2016	Widenhouse et al.
2016/0089137	A1	3/2016	Hess et al.
2016/0106431	A1	4/2016	Shelton, IV et al.
2016/0113653	A1	4/2016	Zingman
2016/0120545	A1	5/2016	Shelton, IV et al.

FOREIGN PATENT DOCUMENTS

CN	2488482	Y	5/2002
CN	1634601	A	7/2005
CN	2716900	Y	8/2005
CN	2738962	Y	11/2005
CN	2868212	Y	2/2007
CN	201949071	U	8/2011
DE	273689	C	5/1914
DE	1775926	A	1/1972
DE	3036217	A1	4/1982
DE	3210466	A1	9/1983
DE	3709067	A1	9/1988
DE	19851291	A1	1/2000
DE	19924311	A1	11/2000
DE	20016423	U1	2/2001
DE	20112837	U1	10/2001
DE	20121753	U1	4/2003
DE	202004012389	U1	9/2004
DE	10314072	A1	10/2004
DE	202007003114	U1	6/2007
EP	0000756	A1	2/1979
EP	0122046	A1	10/1984
EP	0129442	B1	11/1987
EP	0169044	B1	6/1991
EP	0548998	A1	6/1993
EP	0594148	A1	4/1994
EP	0646357	A1	4/1995
EP	0505036	B1	5/1995
EP	0669104	A1	8/1995
EP	0705571	A1	4/1996
EP	0770355	A1	5/1997
EP	0625335	B1	11/1997
EP	0879742	A1	11/1998
EP	0650701	B1	3/1999
EP	0923907	A1	6/1999
EP	0484677	B2	7/2000
EP	1034747	A1	9/2000
EP	1034748	A1	9/2000
EP	1053719	A1	11/2000
EP	1055399	A1	11/2000
EP	1055400	A1	11/2000
EP	1080694	A1	3/2001
EP	1090592	A1	4/2001
EP	1095627	A1	5/2001
EP	0806914	B1	9/2001
EP	1284120	A1	2/2003
EP	0869742	B1	5/2003
EP	1374788	A1	1/2004
EP	1407719	A2	4/2004
EP	0996378	B1	6/2004
EP	1157666	B1	9/2005
EP	0880338	B1	10/2005
EP	1158917	B1	11/2005
EP	1344498	B1	11/2005
EP	1330989	B1	12/2005
EP	1632191	A2	3/2006
EP	1082944	B1	5/2006
EP	1253866	B1	7/2006
EP	1285633	B1	12/2006
EP	1011494	B1	1/2007
EP	1767163	A1	3/2007
EP	1837041	A1	9/2007
EP	0922435	B1	10/2007
EP	1599146	B1	10/2007
EP	1330201	B1	6/2008
EP	2039302	A2	3/2009
EP	1719461	B1	6/2009
EP	1769754	B1	6/2010
EP	1627605	B1	12/2010

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

EP	2316345	A1	5/2011
EP	2486862	A2	8/2012
EP	2517638	A1	10/2012
EP	2649948	A1	10/2013
EP	2649949	A1	10/2013
EP	2713902	A1	4/2014
FR	459743	A	11/1913
FR	999646	A	2/1952
FR	1112936	A	3/1956
FR	2598905	A1	11/1987
FR	2765794	A1	1/1999
FR	2815842	A1	5/2002
GB	939929	A	10/1963
GB	1210522	A	10/1970
GB	1217159	A	12/1970
GB	1339394	A	12/1973
GB	2024012	A	1/1980
GB	2109241	A	6/1983
GB	2272159	A	5/1994
GB	2336214	A	10/1999
GR	930100110	A	11/1993
JP	S4711908	Y1	5/1972
JP	S5033988	U	4/1975
JP	S56112235	A	9/1981
JP	S62170011	U	10/1987
JP	H04215747	A	8/1992
JP	H04131860	U	12/1992
JP	H0584252	A	4/1993
JP	H05123325	A	5/1993
JP	H0630945	A	2/1994
JP	H06237937	A	8/1994
JP	H06327684	A	11/1994
JP	H07124166	A	5/1995
JP	H07255735	A	10/1995
JP	H07285089	A	10/1995
JP	H0833642	A	2/1996
JP	H08164141	A	6/1996
JP	H08182684	A	7/1996
JP	H08507708	A	8/1996
JP	H08229050	A	9/1996
JP	H10118090	A	5/1998
JP	2000014632	A	1/2000
JP	2000033071	A	2/2000
JP	2000112002	A	4/2000
JP	2000166932	A	6/2000
JP	2000171730	A	6/2000
JP	2000287987	A	10/2000
JP	2000325303	A	11/2000
JP	2001087272	A	4/2001
JP	2001514541	A	9/2001
JP	2001276091	A	10/2001
JP	2002051974	A	2/2002
JP	2002085415	A	3/2002
JP	2002143078	A	5/2002
JP	2002528161	A	9/2002
JP	2002314298	A	10/2002
JP	2003135473	A	5/2003
JP	2003521301	A	7/2003
JP	2004147701	A	5/2004
JP	2004162035	A	6/2004
JP	2004229976	A	8/2004
JP	2005080702	A	3/2005
JP	2005131163	A	5/2005
JP	2005131164	A	5/2005
JP	2005131173	A	5/2005
JP	2005131211	A	5/2005
JP	2005131212	A	5/2005
JP	2005137423	A	6/2005
JP	2005328882	A	12/2005
JP	2005335432	A	12/2005
JP	2005342267	A	12/2005
JP	2006187649	A	7/2006
JP	2006281405	A	10/2006
JP	2006346445	A	12/2006
JP	2009507526	A	2/2009
JP	2009189838	A	8/2009
JP	2009539420	A	11/2009
JP	2010069310	A	4/2010
JP	2010098844	A	4/2010
KR	20110003229	A	1/2011
RU	2008830	C1	3/1994
RU	2052979	C1	1/1996
RU	2098025	C1	12/1997
RU	2141279	C1	11/1999
RU	2144791	C1	1/2000
RU	2181566	C2	4/2002
RU	2187249	C2	8/2002
RU	32984	U1	10/2003
RU	2225170	C2	3/2004
RU	42750	U1	12/2004
RU	61114	U1	2/2007
SU	189517	A	1/1967
SU	328636	A	9/1972
SU	674747	A1	7/1979
SU	1009439	A	4/1983
SU	1333319	A2	8/1987
SU	1377053	A1	2/1988
SU	1509051	A1	9/1989
SU	1561964	A1	5/1990
SU	1708312	A1	1/1992
SU	1722476	A1	3/1992
SU	1752361	A1	8/1992
SU	1814161	A1	5/1993
WO	WO-9315648	A1	8/1993
WO	WO-9420030	A1	9/1994
WO	WO-9517855	A1	7/1995
WO	WO-9520360	A1	8/1995
WO	WO-9623448	A1	8/1996
WO	WO-9635464	A1	11/1996
WO	WO-9639086	A1	12/1996
WO	WO-9639088	A1	12/1996
WO	WO-9724073	A1	7/1997
WO	WO-9734533	A1	9/1997
WO	WO-9903407	A1	1/1999
WO	WO-9903409	A1	1/1999
WO	WO-9948430	A1	9/1999
WO	WO-0024322	A1	5/2000
WO	WO-0024330	A1	5/2000
WO	WO-0053112	A2	9/2000
WO	WO-0057796	A1	10/2000
WO	WO-0105702	A1	1/2001
WO	WO-0154594	A1	8/2001
WO	WO-0158371	A1	8/2001
WO	WO-0162164	A2	8/2001
WO	WO-0162169	A2	8/2001
WO	WO-0191646	A1	12/2001
WO	WO-0219932	A1	3/2002
WO	WO-0226143	A1	4/2002
WO	WO-0236028	A1	5/2002
WO	WO-02065933	A2	8/2002
WO	WO-03055402	A1	7/2003
WO	WO-03094747	A1	11/2003
WO	WO-03079909	A3	3/2004
WO	WO-2004019803	A1	3/2004
WO	WO-2004032783	A1	4/2004
WO	WO-2004047626	A1	6/2004
WO	WO-2004047653	A2	6/2004
WO	WO-2004056277	A1	7/2004
WO	WO-2004078050	A2	9/2004
WO	WO-2004078051	A2	9/2004
WO	WO-2004096015	A2	11/2004
WO	WO-2006044581	A2	4/2006
WO	WO-2006051252	A1	5/2006
WO	WO-2006059067	A1	6/2006
WO	WO-2006085389	A1	8/2006
WO	WO-2007074430	A1	7/2007
WO	WO-2007129121	A1	11/2007
WO	WO-2007137304	A2	11/2007
WO	WO-2007142625	A2	12/2007
WO	WO-2008021969	A2	2/2008
WO	WO-2008089404	A2	7/2008
WO	WO-2009005969	A2	1/2009
WO	WO-2009067649	A2	5/2009
WO	WO-2009091497	A2	7/2009

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

WO	WO-2011008672	A2	1/2011
WO	WO-2011044343	A2	4/2011
WO	WO-2012006306	A2	1/2012
WO	WO-2012044606	A2	4/2012

OTHER PUBLICATIONS

Fast, Versatile Blackfin Processors Handle Advanced RFID Reader Applications; Analog Dialogue: vol. 40—Sep. 2006; http://www.analog.com/library/analogDialogue/archives/40-09/rfid.pdf; Wayback Machine to Feb. 15, 2012.
Covidien Brochure, "Endo GIA™ Black Reload with Tri-Staple™ Technology," (2012), 2 pages.
The Sodem Aseptic Battery Transfer Kit, Sodem Systems, 2000, 3 pages.
Schellhammer et al., "Poly-Lactic-Acid for Coating of Endovascular Stents: Preliminary Results in Canine Experimental Av-Fistulae," Mat.-wiss. u. Werkstofftech., 32, pp. 193-199 (2001).
Miyata et al., "Biomolecule-Sensitive Hydrogels," Advanced Drug Delivery Reviews, 54 (2002) pp. 79-98.
Jeong et al., "Thermosensitive Sol-Gel Reversible Hydrogels," Advanced Drug Delivery Reviews, 54 (2002) pp. 37-51.
Covidien Brochure, "Endo GIA™ Ultra Universal Stapler," (2010), 2 pages.
Qiu et al., "Environment-Sensitive Hydrogels for Drug Delivery," Advanced Drug Delivery Reviews, 53 (2001) pp. 321-339.
Hoffman, "Hydrogels for Biomedical Applications," Advanced Drug Delivery Reviews, 43 (2002) pp. 3-12.
Hoffman, "Hydrogels for Biomedical Applications," Advanced Drug Delivery Reviews, 54 (2002) pp. 3-12.
Peppas, "Physiologically Responsive Hydrogels," Journal of Bioactive and Compatible Polymers, vol. 6 (Jul. 1991) pp. 241-246.
Peppas, Editor "Hydrogels in Medicine and Pharmacy," vol. I, Fundamentals, CRC Press, 1986.
Young, "Microcellular foams via phase separation," Journal of Vacuum Science & Technology A 4(3), (May/Jun. 1986).
Chen et al., "Elastomeric Biomaterials for Tissue Engineering," Progress in Polymer Science 38 (2013), pp. 584-671.
Ebara, "Carbohydrate-Derived Hydrogels and Microgels," Engineered Carbohydrate-Based Materials for Biomedical Applications: Polymers, Surfaes, Dendrimers, Nanoparticles, and Hydrogels, Edited by Ravin Narain, 2011, pp. 337-345.
Matsuda, "Thermodynamics of Formation of Porous Polymeric Membrane from Solutions," Polymer Journal, vol. 23, No. 5, pp. 435-444 (1991).
Byrne et al., "Molecular Imprinting Within Hydrogels," Advanced Drug Delivery Reviews, 54 (2002) pp. 149-161.
Covidien Brochure, "Endo GIA™ Reloads with Tri-Staple™ Technology," (2010), 1 page.
Covidien Brochure, "Endo GIA™ Reloads with Tri-Staple™ Technology and Endo GIA™ Ultra Universal Staplers," (2010), 2 pages.
Covidien Brochure, "Endo GIA™ Curved Tip Reload with Tri-Staple™ Technology," (2012), 2 pages.
Covidien Brochure, "Endo GIA™ Reloads with Tri-Staple™ Technology," (2010), 2 pages.
http://ninpgan.net/publications/51-100/89.pdf; 2004, Ning Pan, on Uniqueness of Fibrous Materials, Design & Nature II. Eds: Colins, M. and Brebbia, C. WIT Press, Boston, 493-504.
D. Tuite, Ed., "Get the Lowdown on Ultracapacitors," Nov. 15, 2007; [online] URL: http://electronicdesign.com/Articles/Print.cfm?ArticleID=17465, accessed Jan. 15, 2008 (5 pages).
C.C. Thompson et al., "Peroral Endoscopic Reduction of Dilated Gastrojejunal Anastomosis After Roux-en-Y Gastric Bypass: A Possible New Option for Patients with Weight Regain," Surg Endosc (2006) vol. 20., pp. 1744-1748.
Datasheet for Panasonic TK Relays Ultra Low Profile 2 A Polarized Relay, Copyright Matsushita Electric Works, Ltd. (Known of at least as early as Aug. 17, 2010), 5 pages.
B.R. Coolman, DVM, MS et al., "Comparison of Skin Staples With Sutures for Anastomosis of the Small Intestine in Dogs," Abstract; http://www.blackwell-synergy.com/doi/abs/10.1053/jvet.2000.7539?cookieSet=1&journalCode=vsu which redirects to http://www3.interscience.wiley.com/journal/119040681/abstract?CRETRY=1&SRETRY=0; [online] accessed: Sep. 22, 2008 (2 pages).
Indian Standard: Automotive Vehicles—Brakes and Braking Systems (IS 11852-1:2001), Mar. 1, 2001.
Disclosed Anonymously, "Motor-Driven Surgical Stapler Improvements," Research Disclosure Database No. 526041, Published: Feb. 2008.
Van Meer et al., "A Disposable Plastic Compact Wrist for Smart Minimally Invasive Surgical Tools," LAAS/CNRS (Aug. 2005).
Breedveld et al., "A New, Easily Miniaturized Sterrable Endoscope," IEEE Engineering in Medicine and Biology Magazine (Nov./Dec. 2005).
ASTM procedure D2240-00, "Standard Test Method for Rubber Property-Durometer Hardness," (Published Aug. 2000).
ASTM procedure D2240-05, "Standard Test Method for Rubber Property-Durometer Hardness," (Published Apr. 2010).
Pitt et al., "Attachment of Hyaluronan to Metallic Surfaces," J. Biomed. Mater. Res. 68A: pp. 95-106, 2004.
Solorio et al., "Gelatin Microspheres Crosslinked with Genipin for Local Delivery of Growth Factors," J. Tissue Eng. Regen. Med. (2010), 4(7): pp. 514-523.
Covidien iDrive™ Ultra in Service Reference Card, "iDrive™ Ultra Powered Stapling Device," (4 pages).
Covidien iDrive™ Ultra Powered Stapling System ibrochure, "The Power of iDrive™ Ultra Powered Stapling System and Tri-Staple™ Technology," (23 pages).
Covidien "iDrive™ Ultra Powered Stapling System, A Guide for Surgeons," (6 pages).
Covidien "iDrive™ Ultra Powered Stapling System, Cleaning and Sterilization Guide," (2 pages).
Covidien Brochure "iDrive™ Ultra Powered Stapling System," (6 pages).
Seils et al., Covidien Summary: Clinical Study "UCONN Biodynamics: Final Report on Results," (2 pages).
Biomedical Coatings, Fort Wayne Metals, Research Products Corporation, obtained online at www.fwmetals.com on Jun. 21, 2010 (1 page).

* cited by examiner

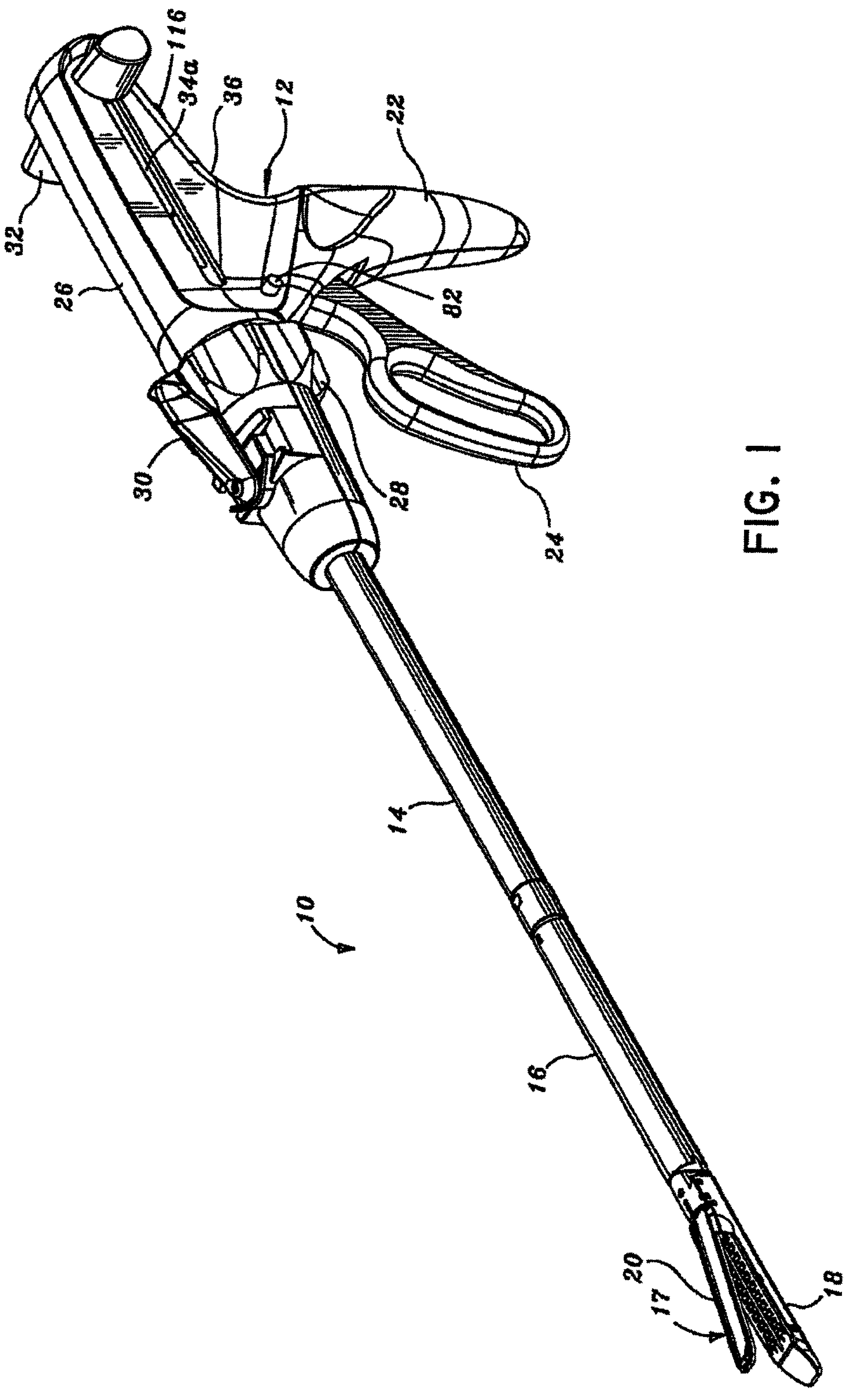
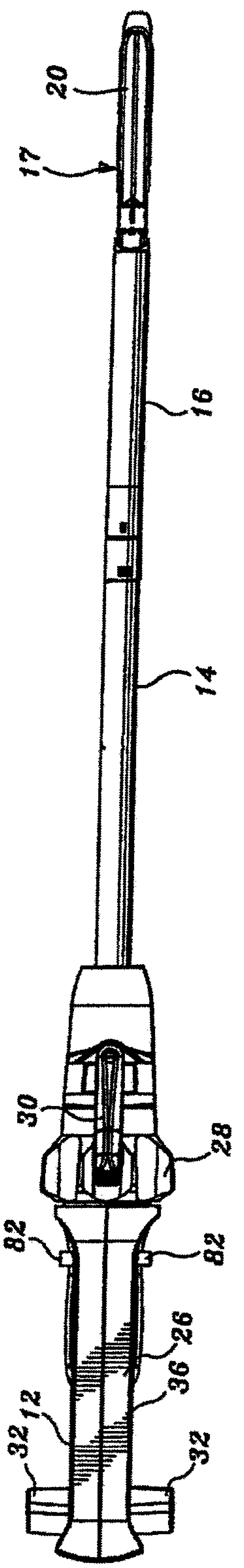
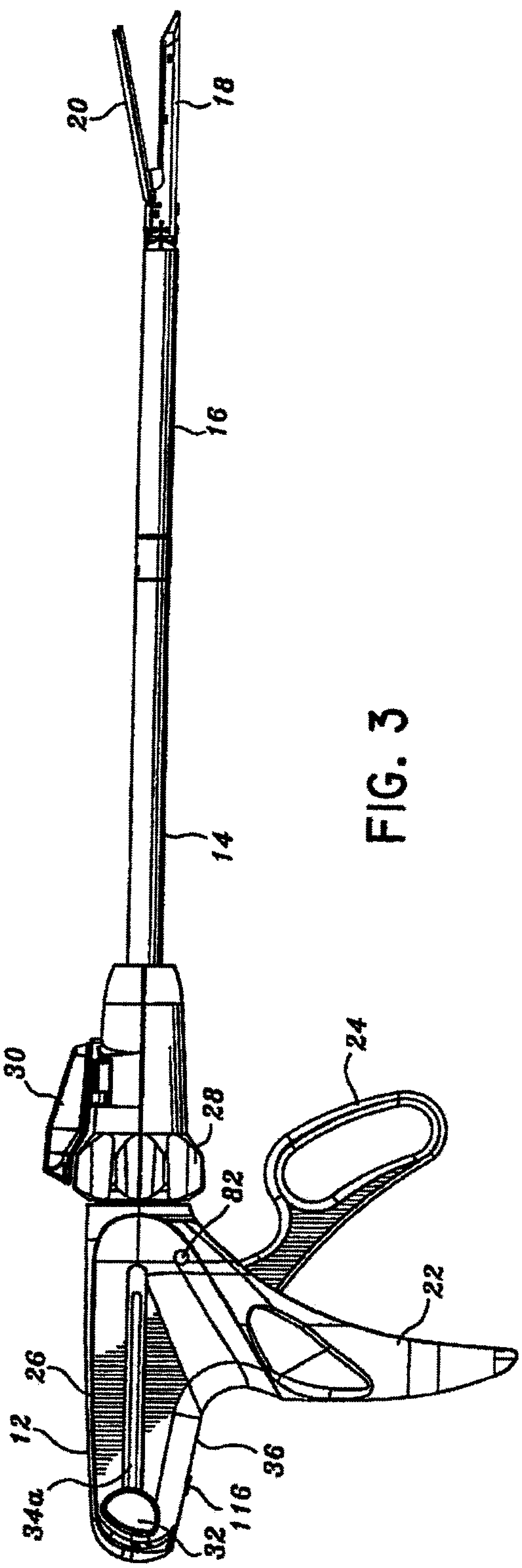


FIG. 1



20
17
16
14
30
28
82
82
26
36
12
32
32

FIG. 2



20
18
16
14
30
28
24
82
22
26
12
36
34a
116
32

FIG. 3

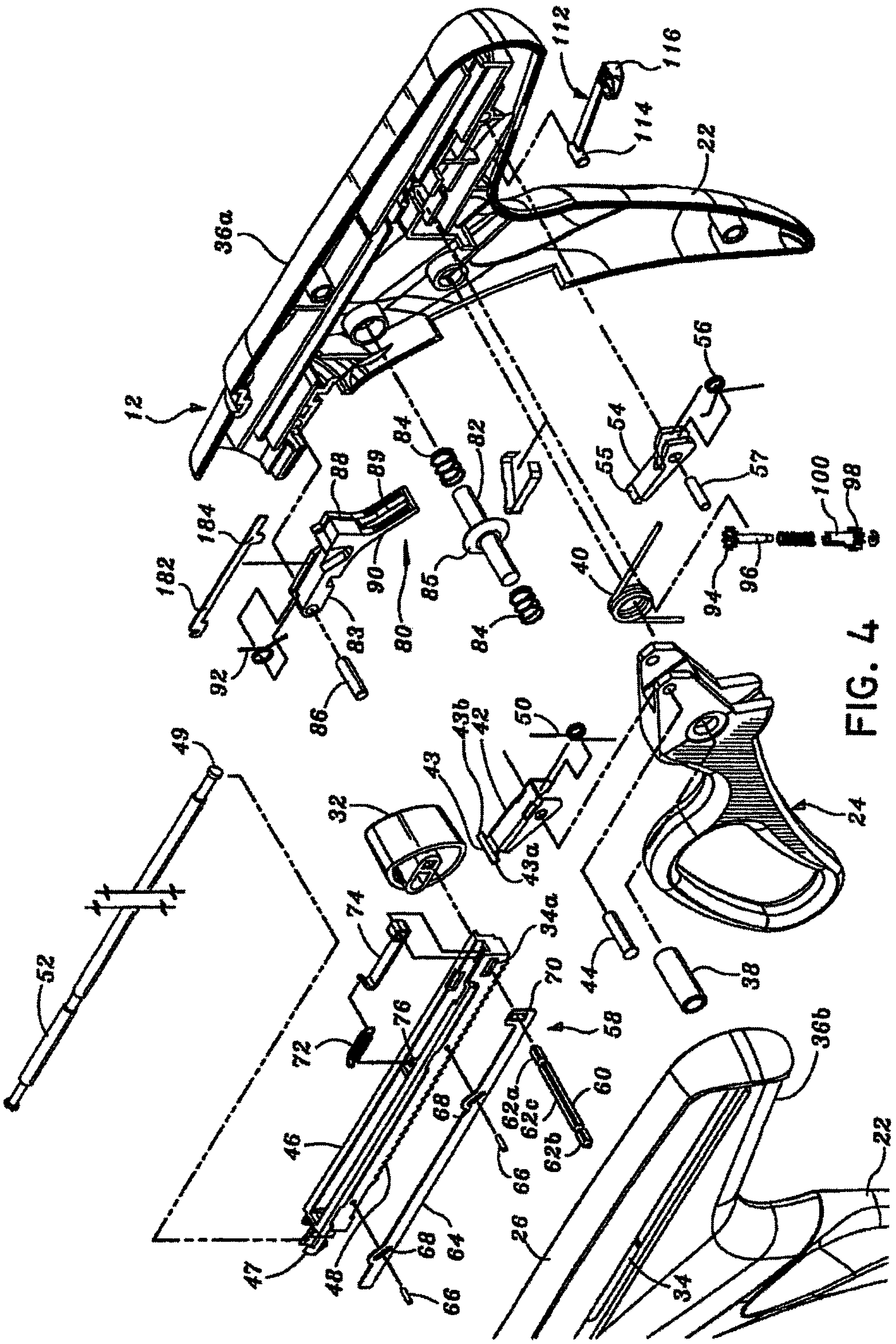

12
36a
112
116
114
22
56
54
55
57
100
98
96
94
84
82
88
89
184
182
90
85
84
80
83
92
86
40
49
52
32
43b
42
43
43a
50
24
74
34a
70
44
38
72
76
58
60
62a
62c
62b
66
68
46
64
68
66
47
48
26
36b
34
22

FIG. 4

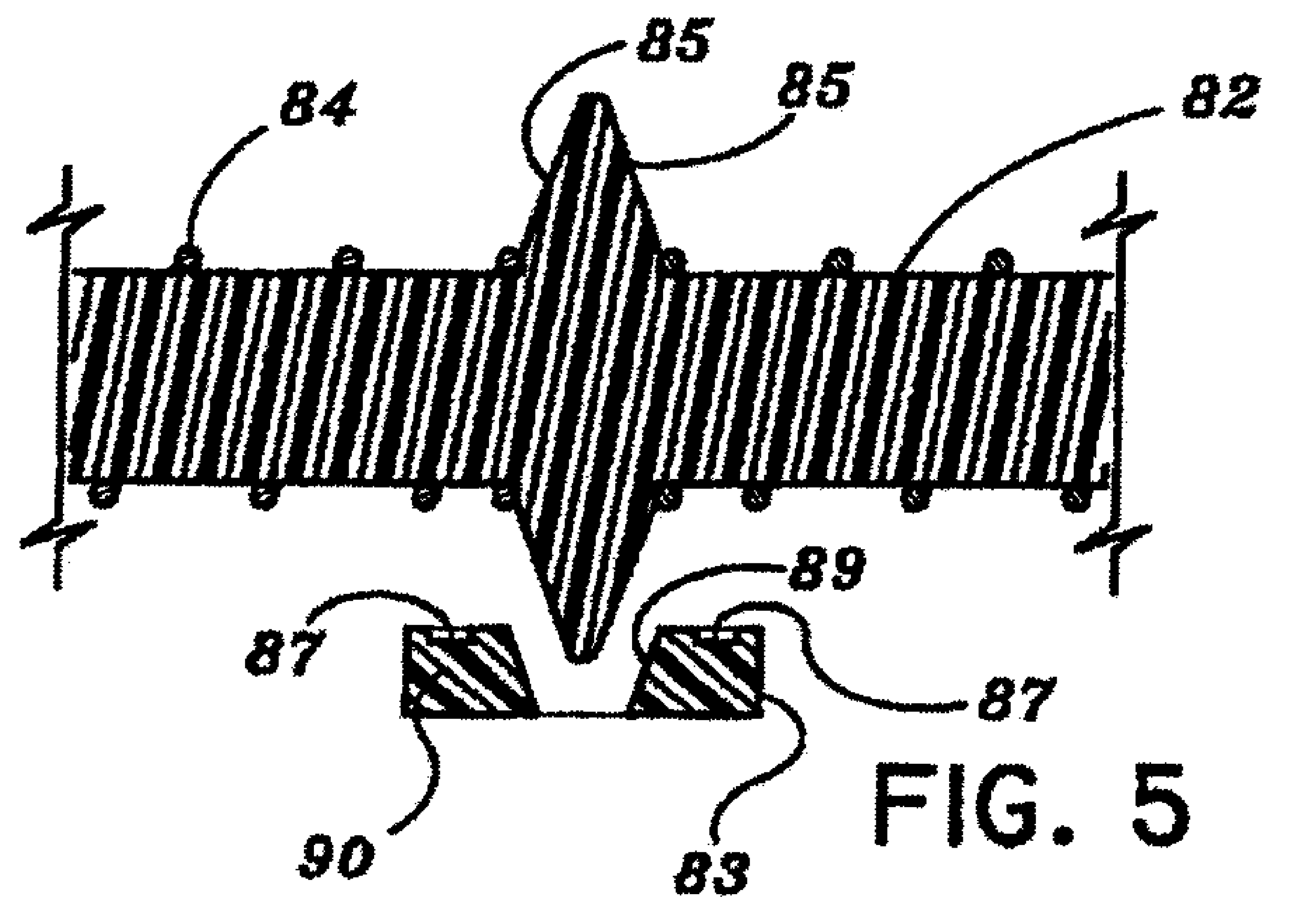


FIG. 5

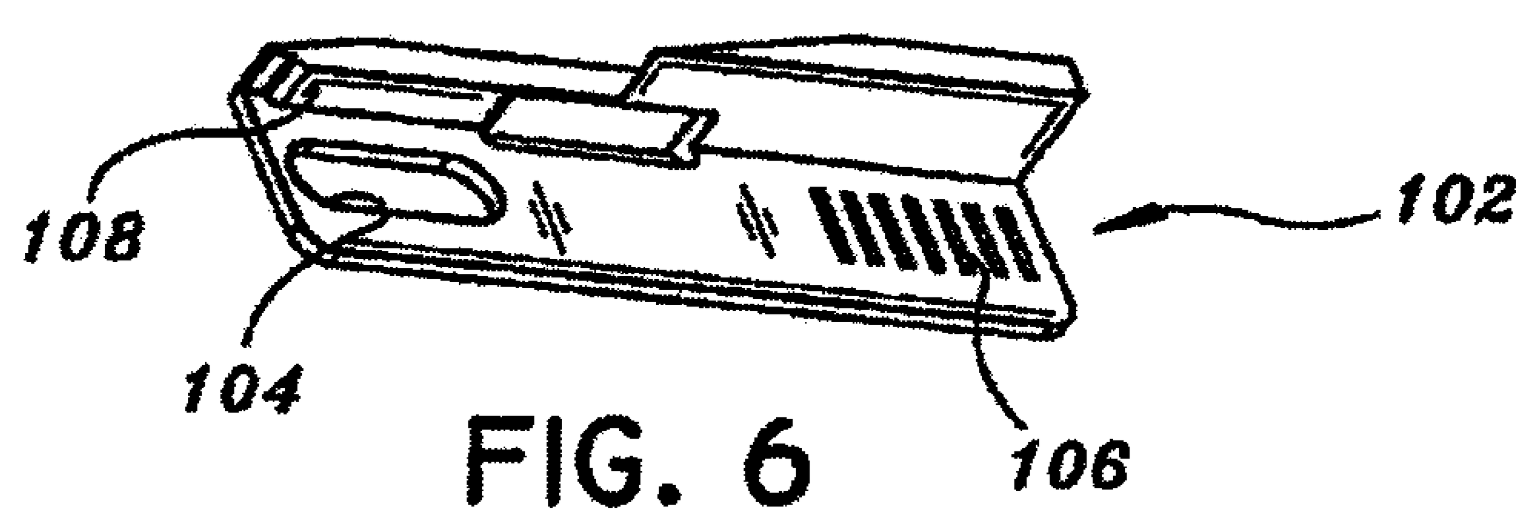


FIG. 6

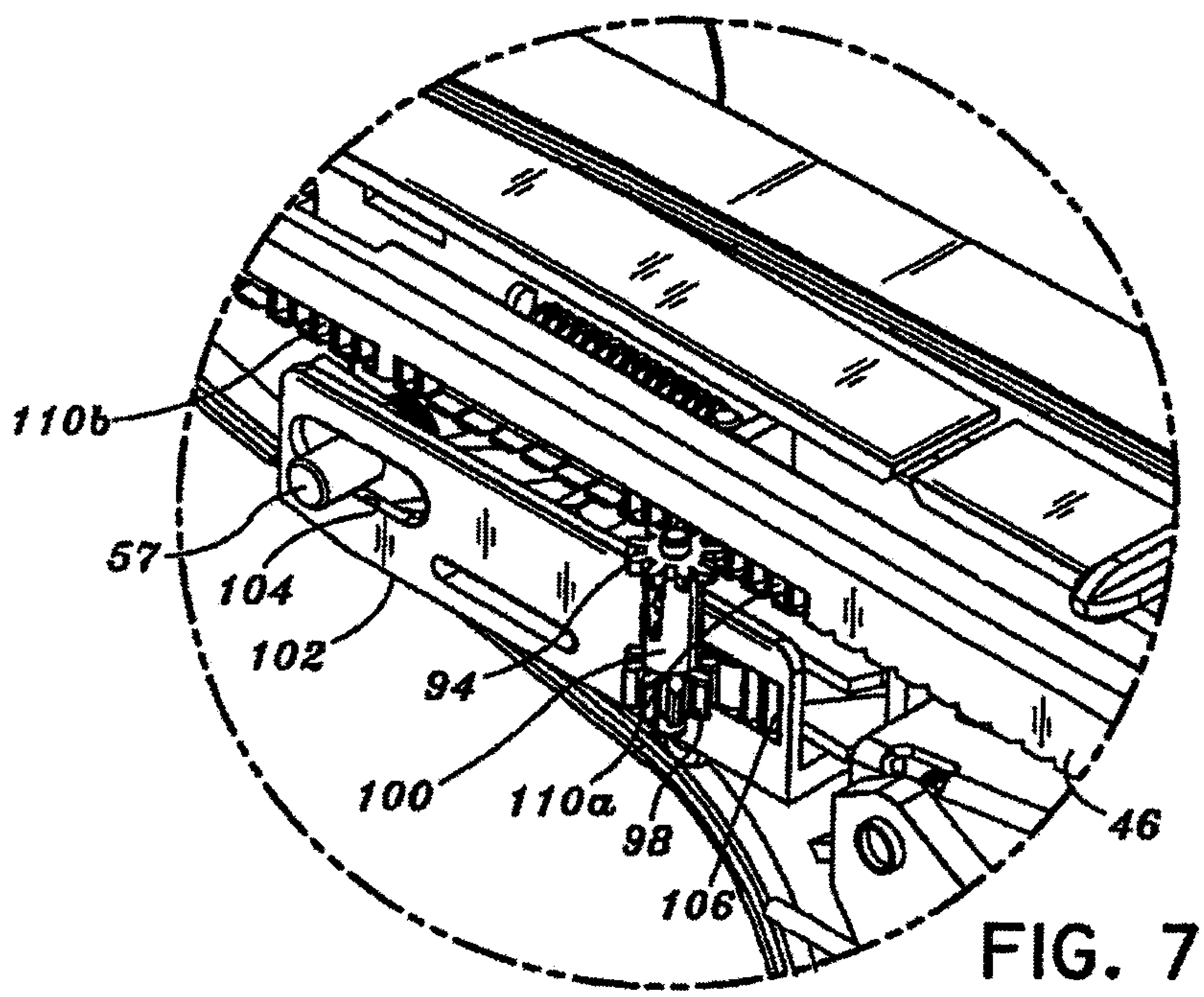


FIG. 7

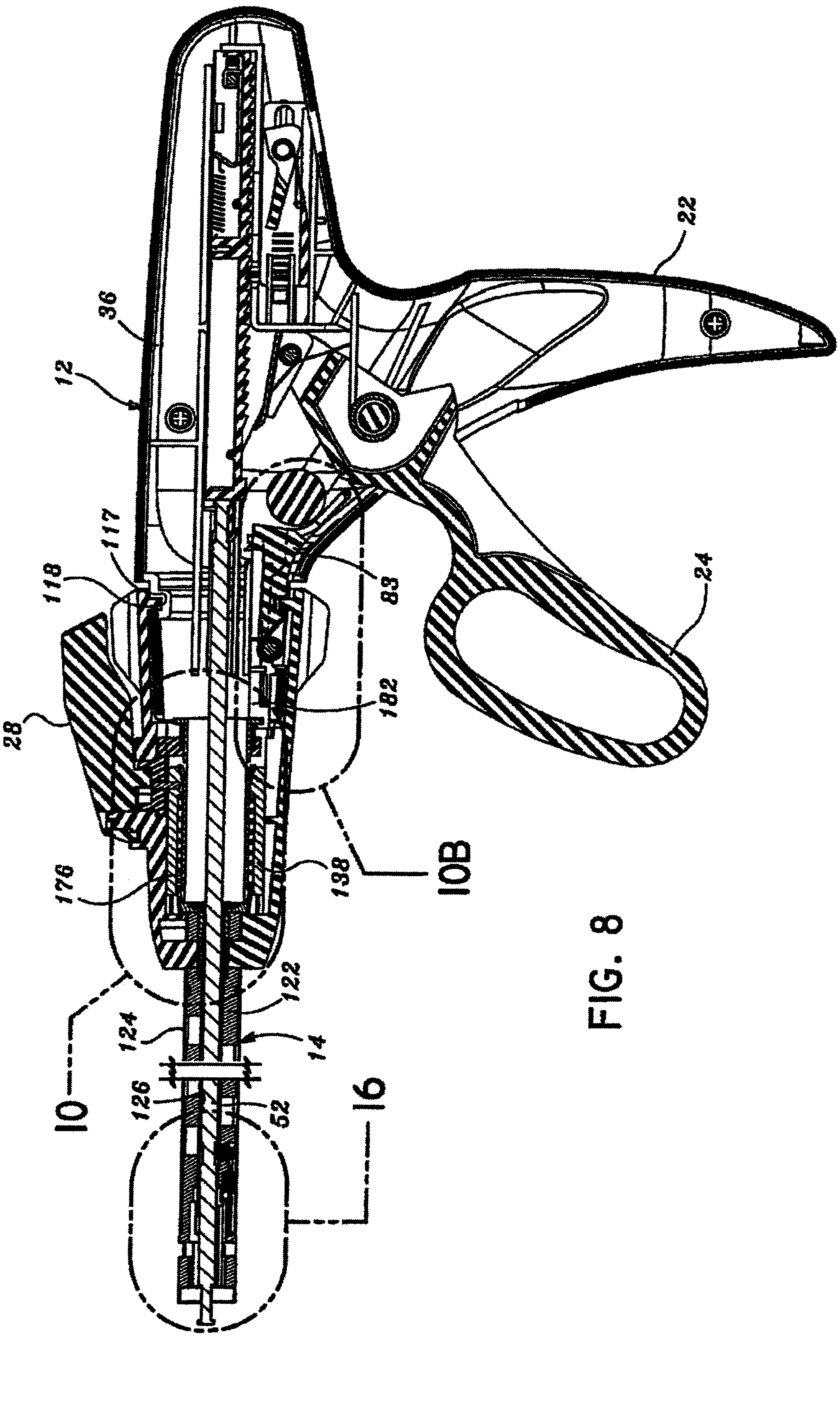


FIG. 8

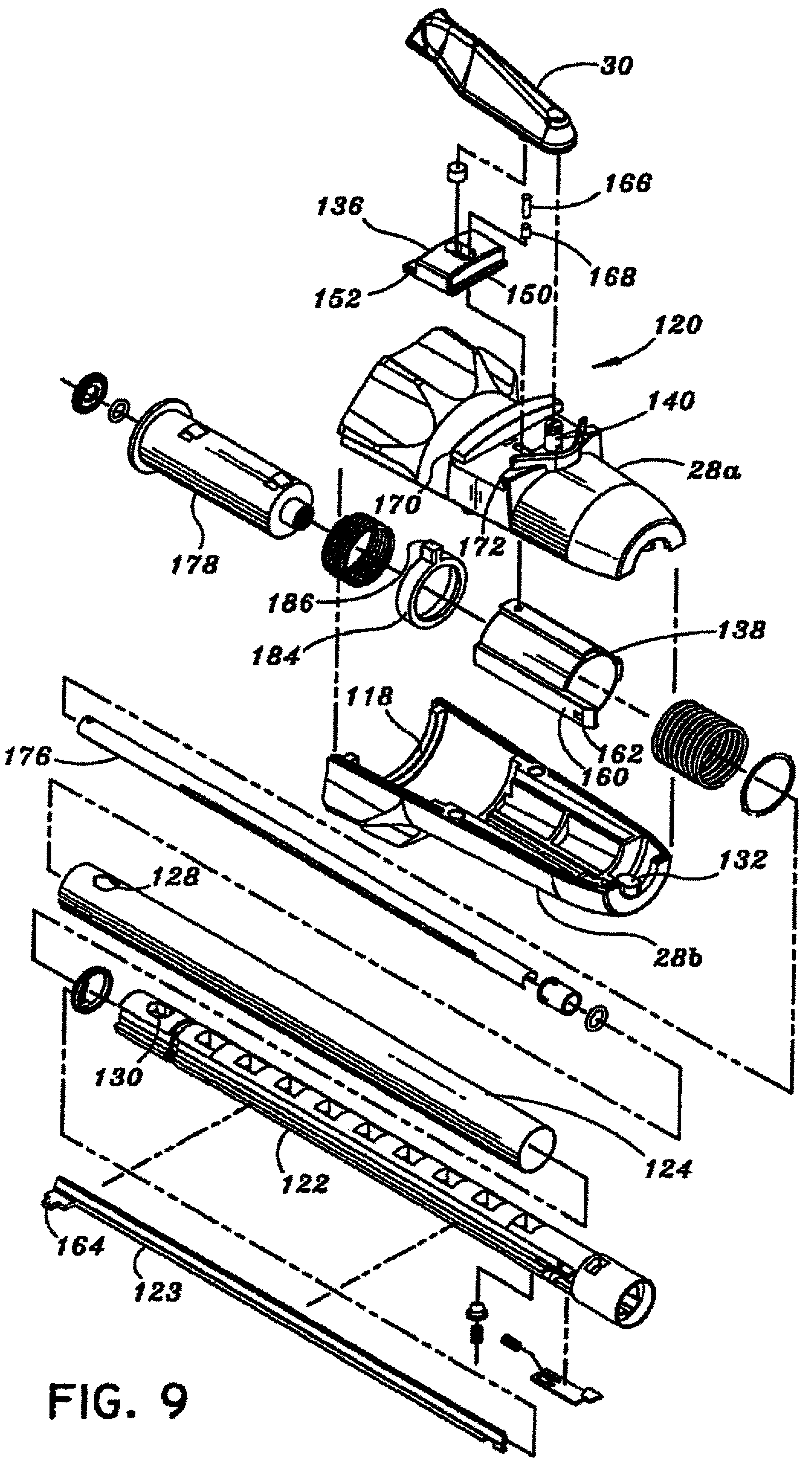
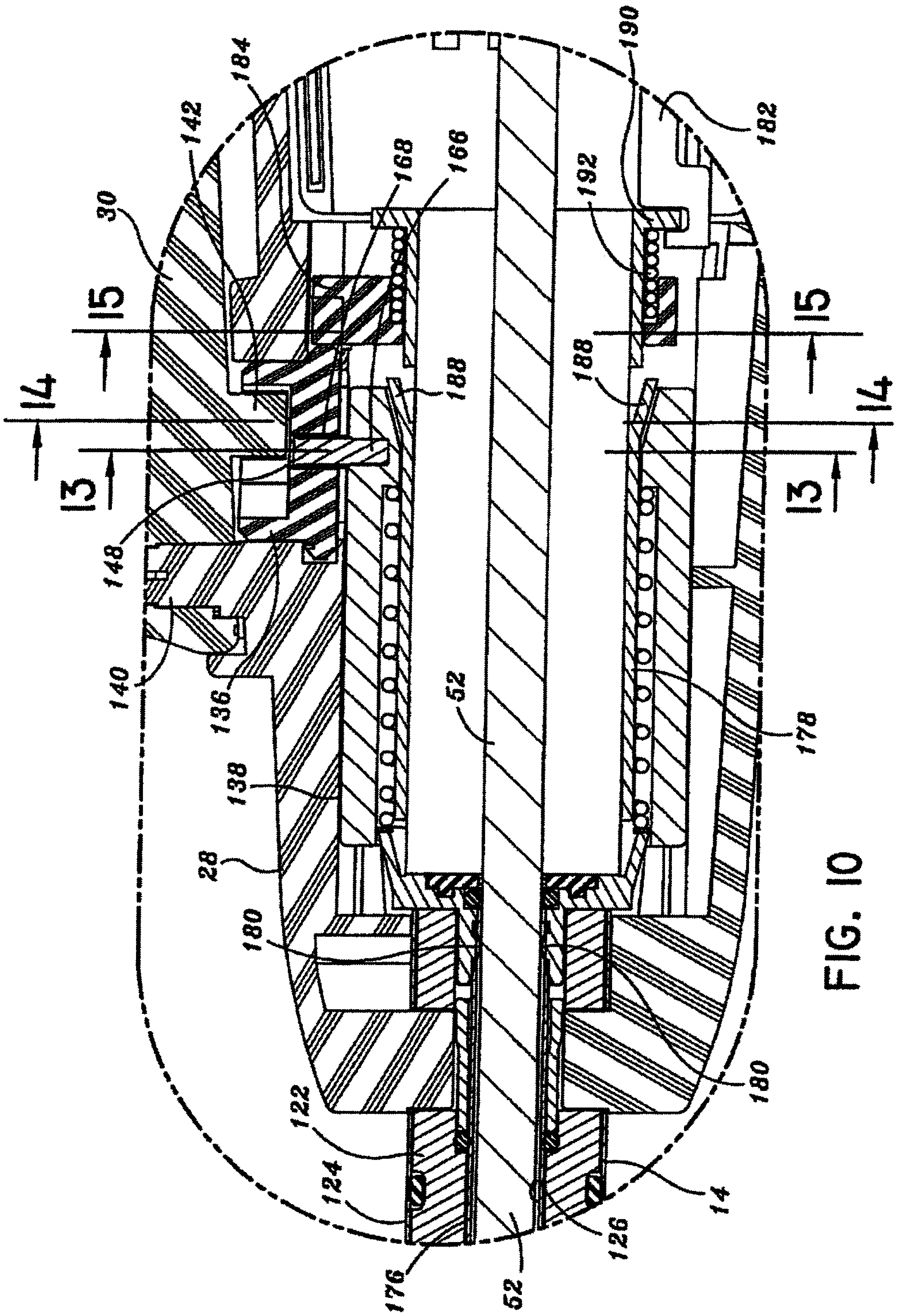

30
166
136
168
152
150
120
140
28a
170
172
178
186
184
138
118
176
162
160
132
128
28b
130
124
122
164
123

FIG. 9



30
142
184
168
166
190
182
192
15
14
13
188
148
140
136
138
52
178
28
180
122
124
176
126
14

FIG. 10

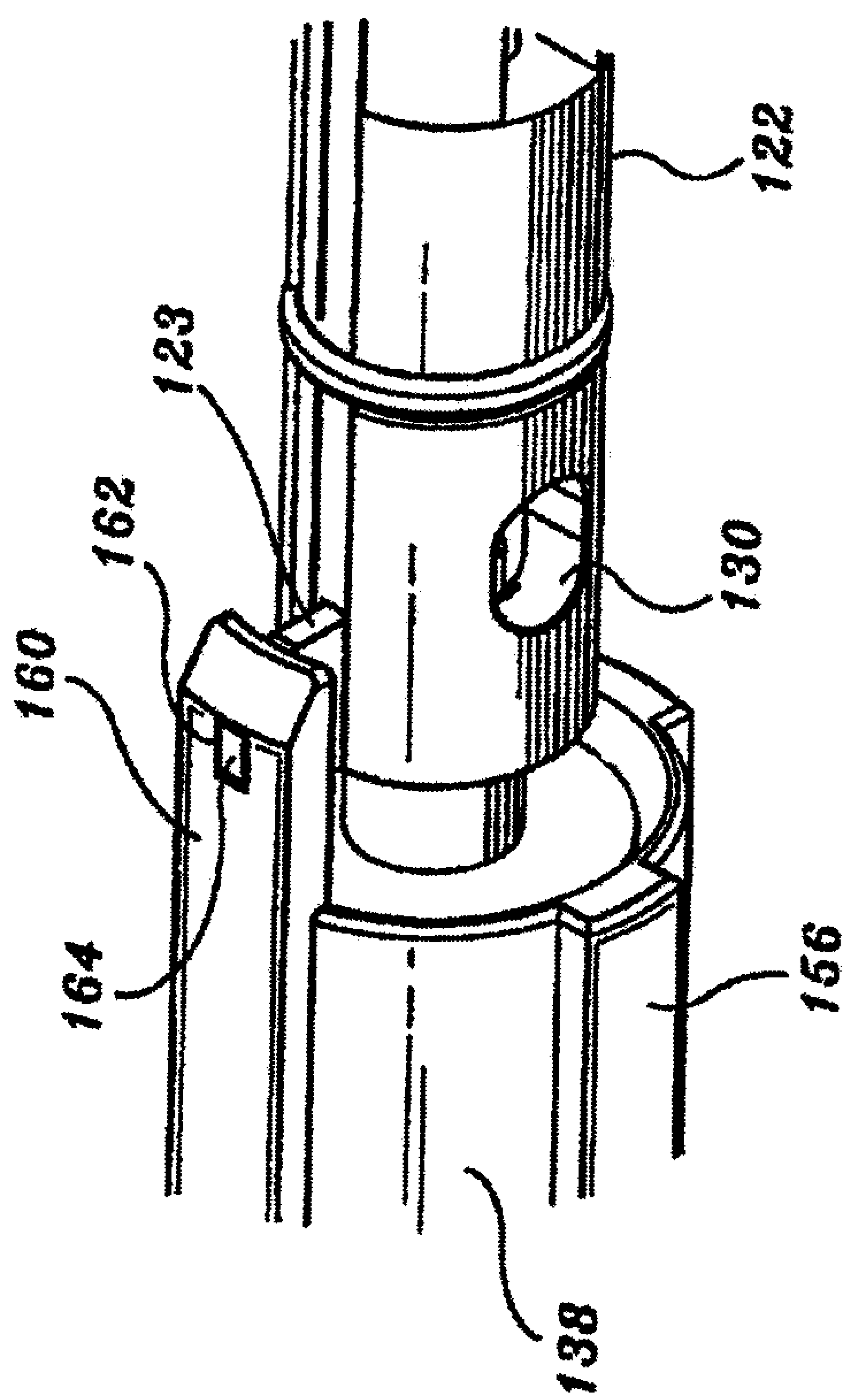


FIG. 10A

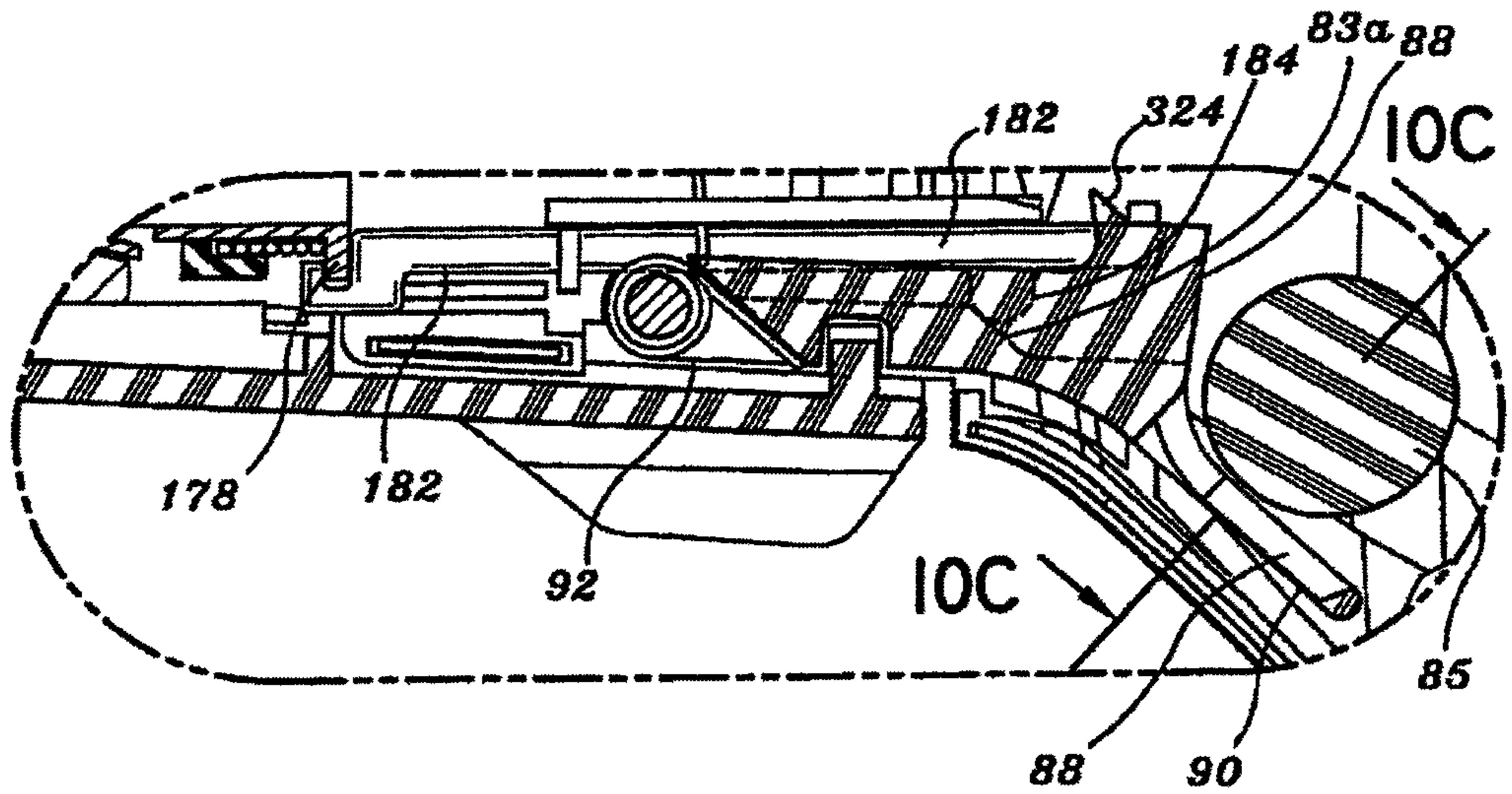


FIG. 10B

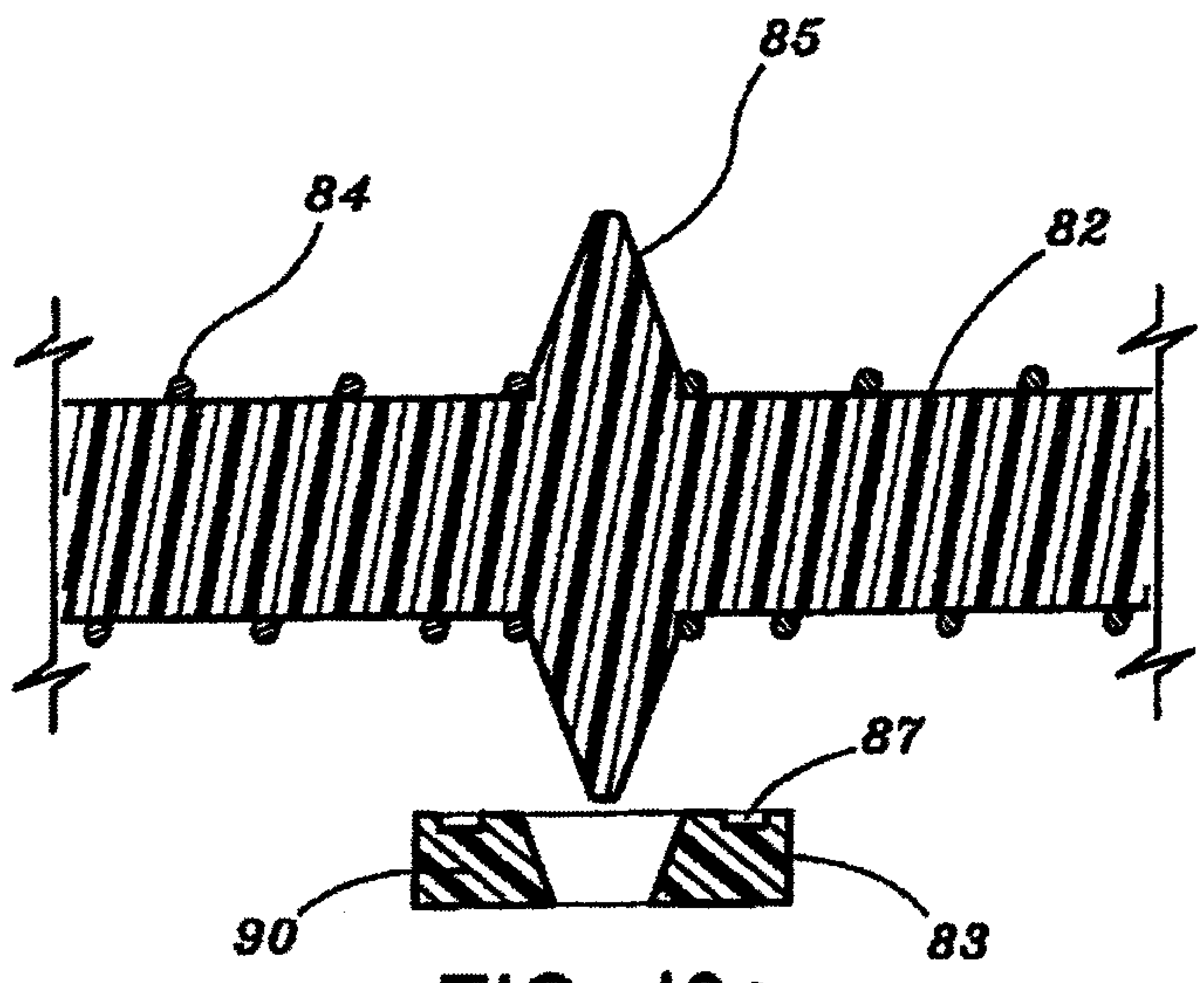


FIG. 10c

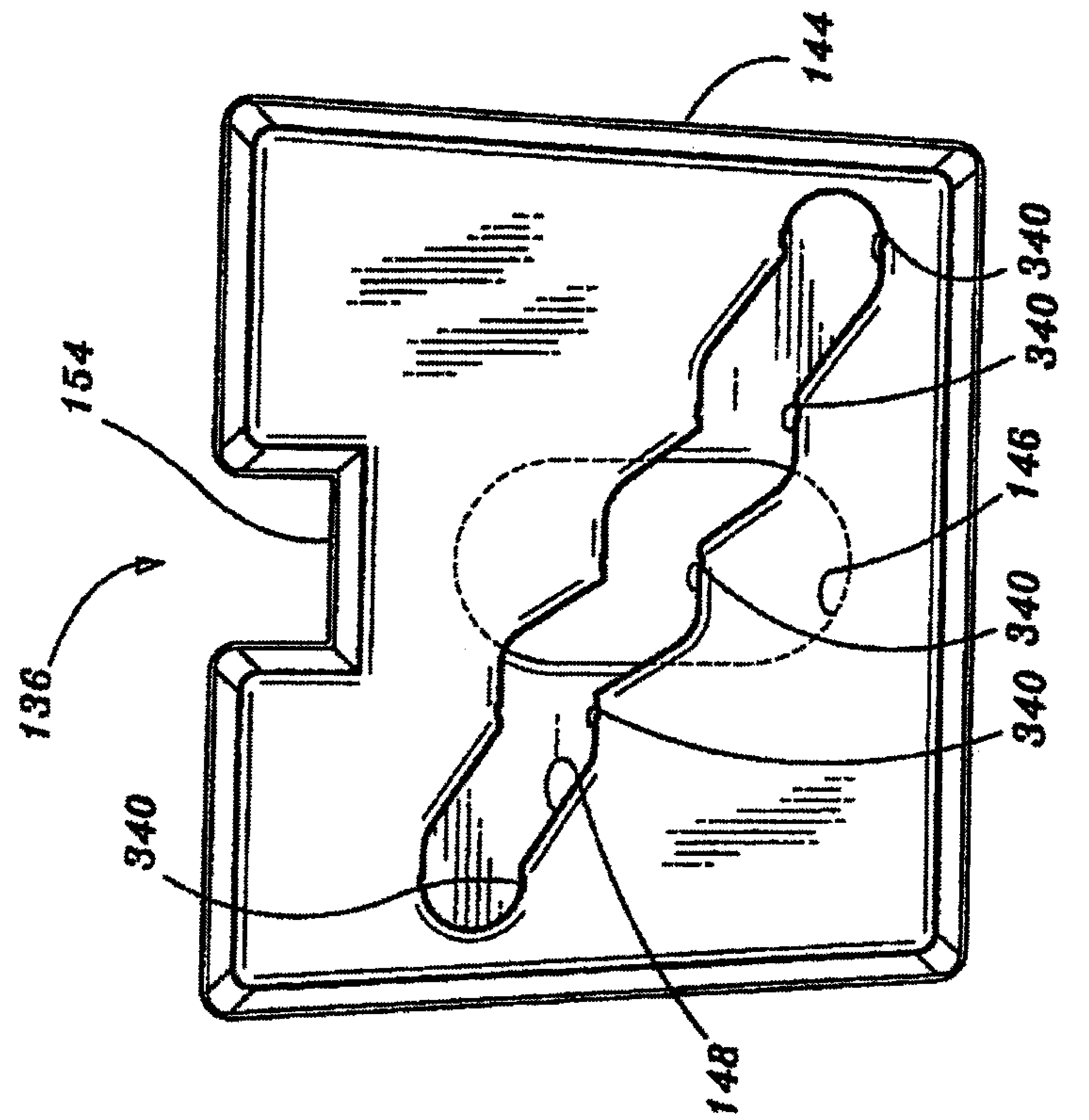


FIG. 12

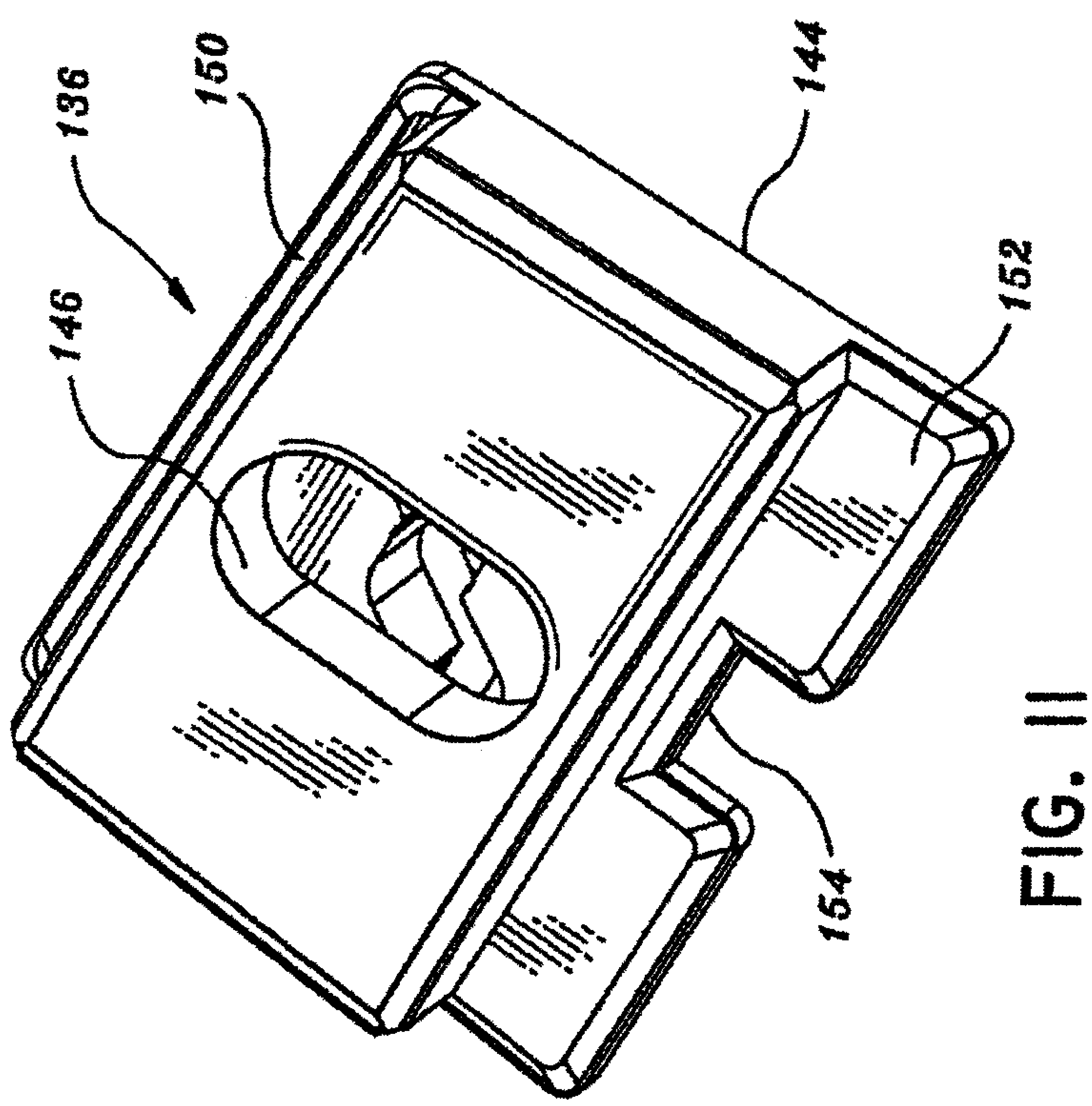


FIG. 11

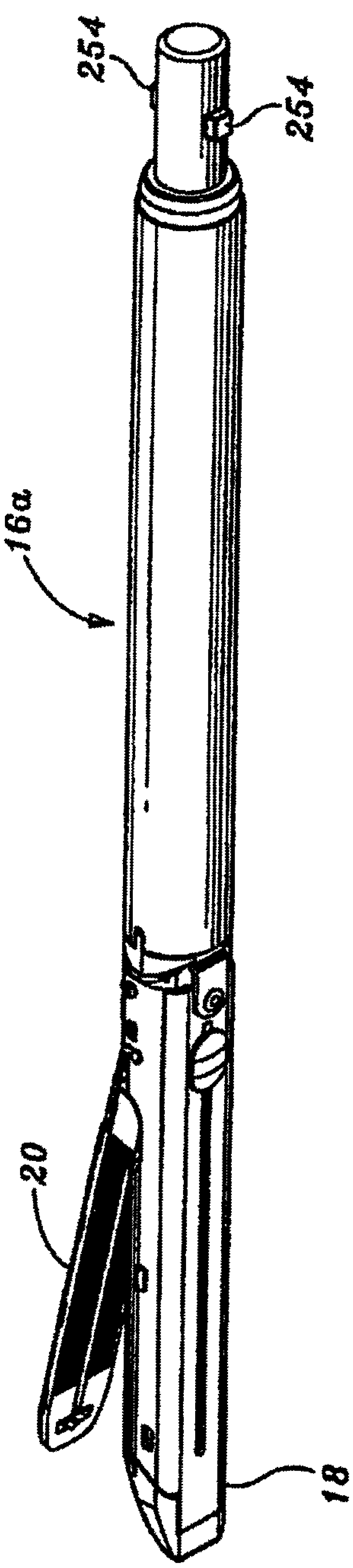


FIG. 12A

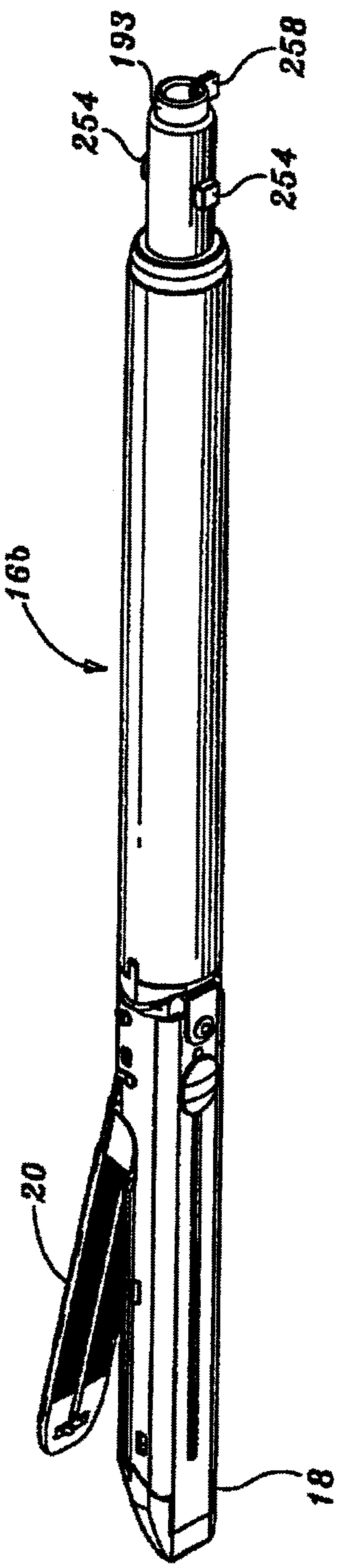


FIG. 12B

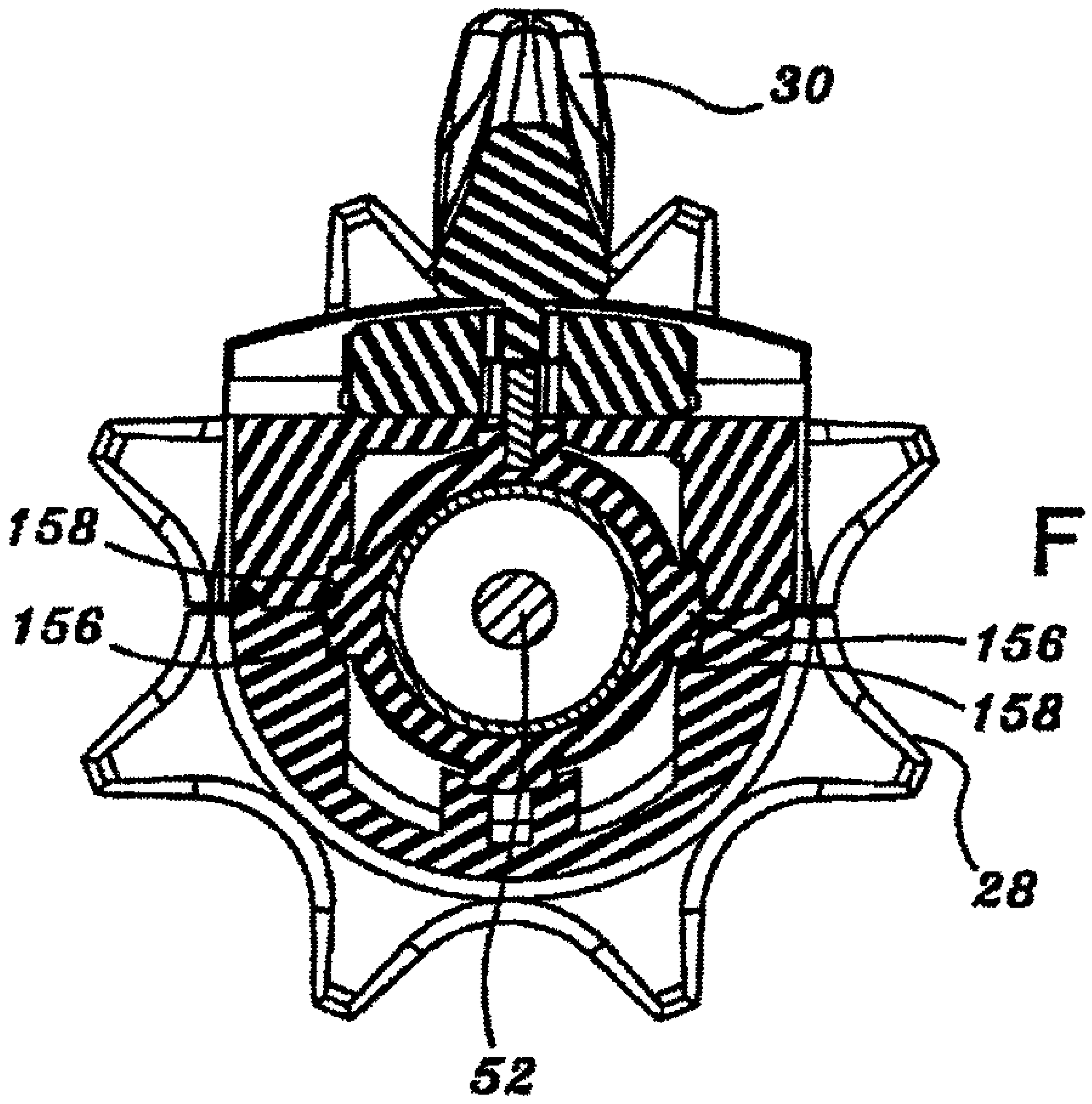


FIG. 13

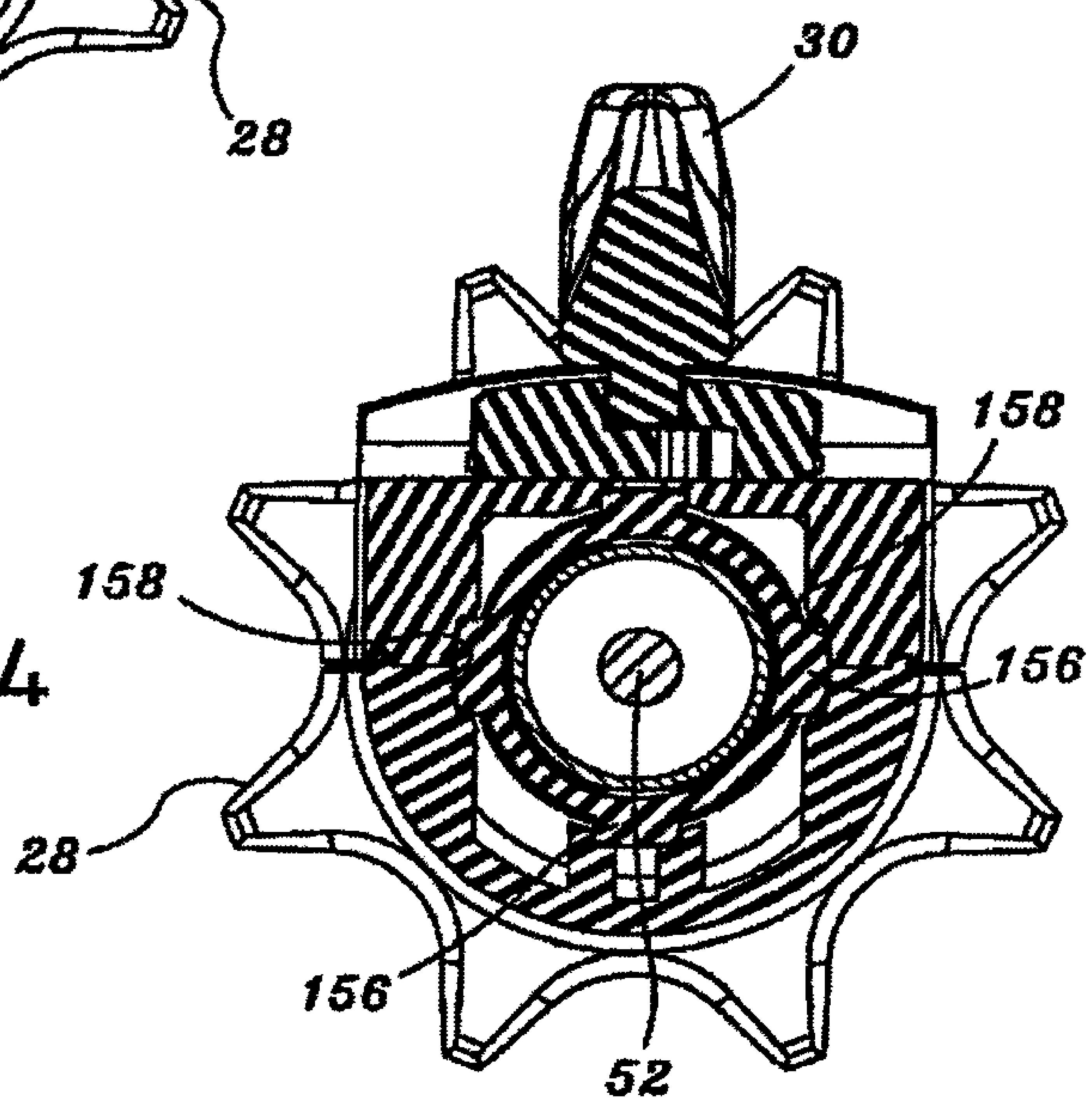


FIG. 14

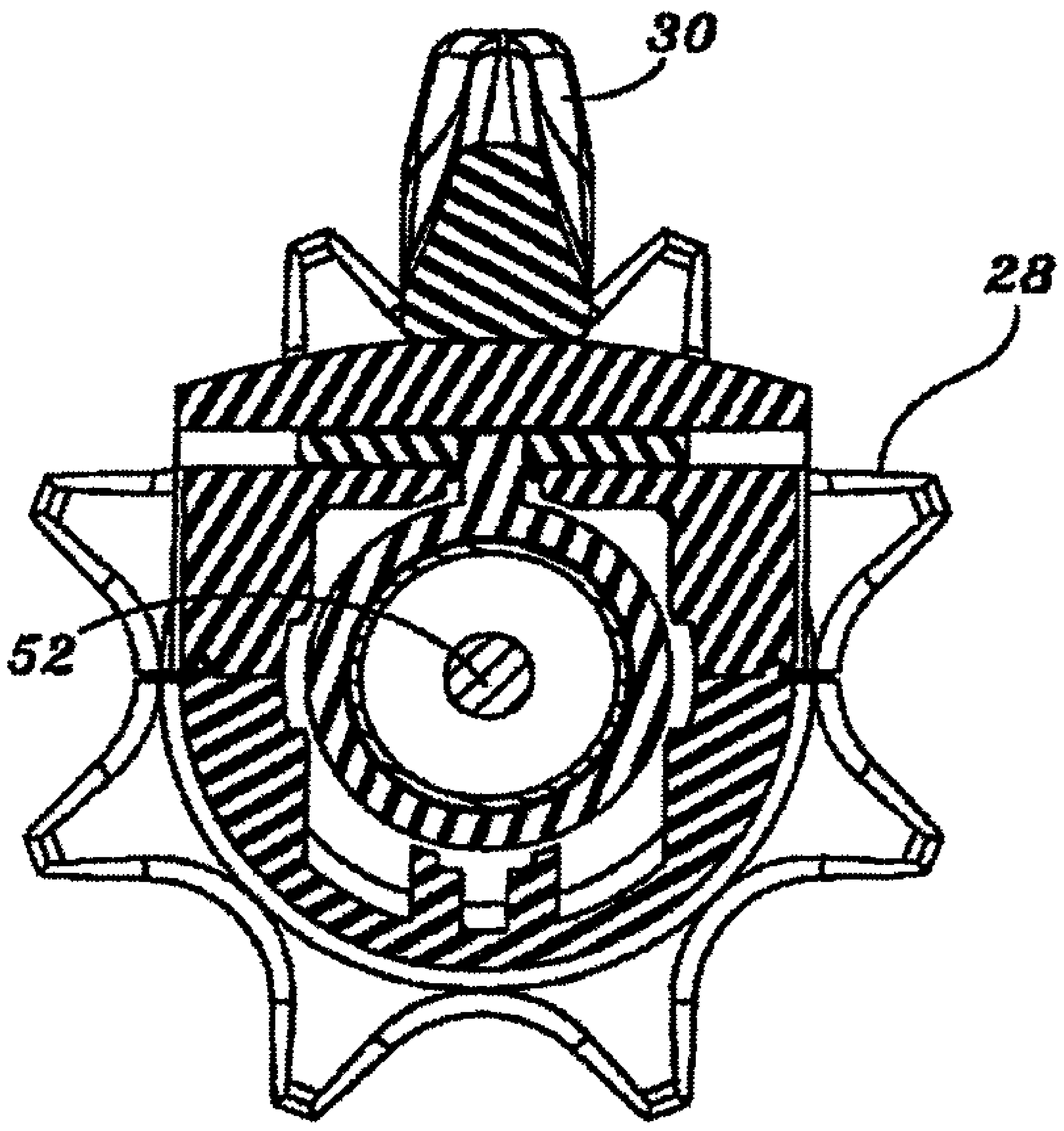


FIG. 15

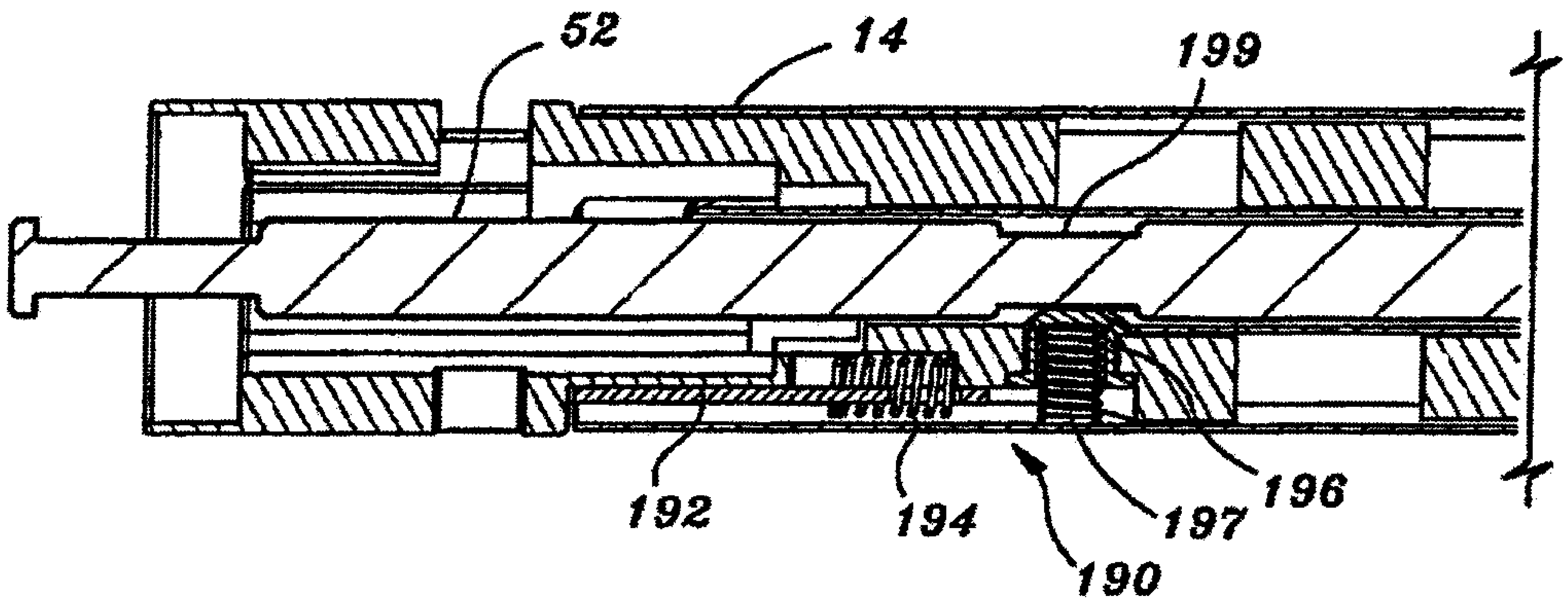


FIG. 16

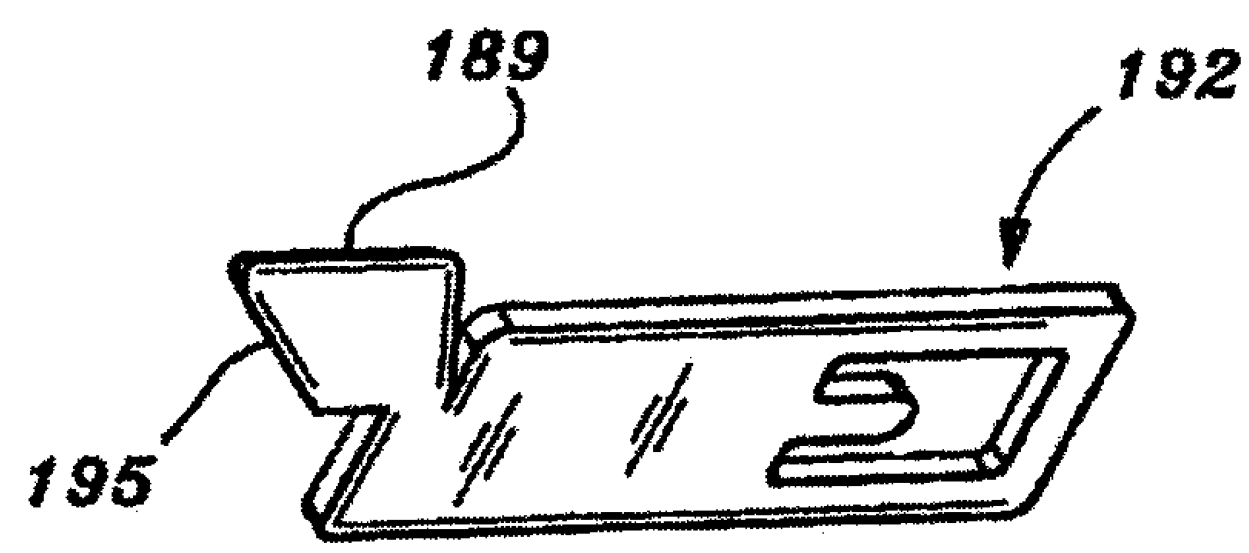


FIG. 17

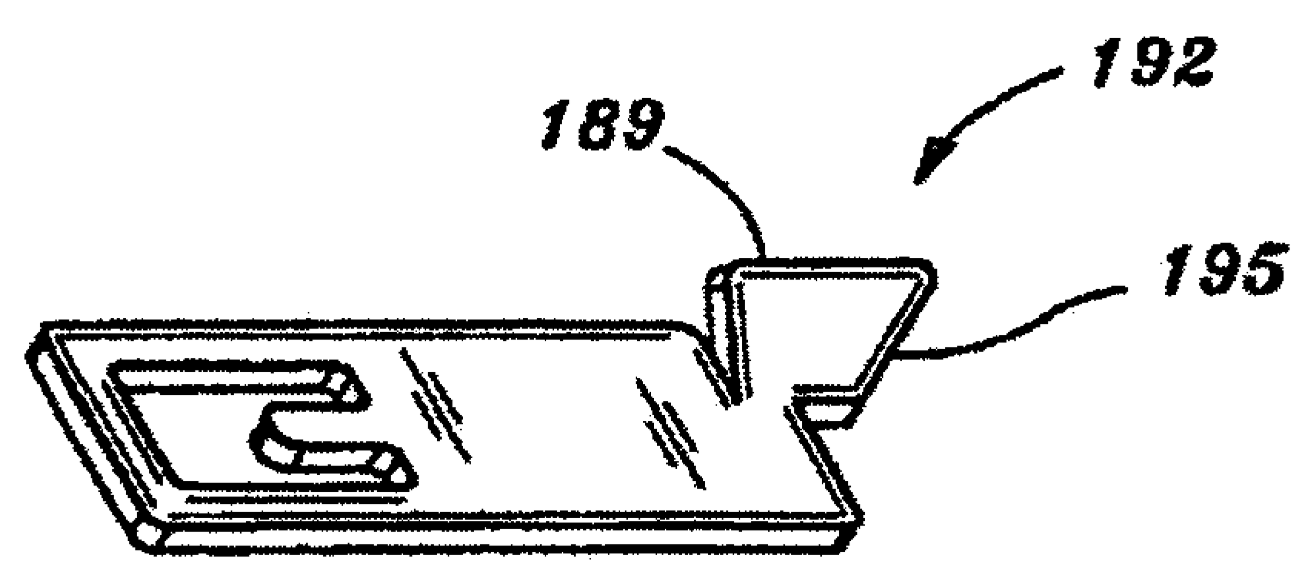


FIG. 18

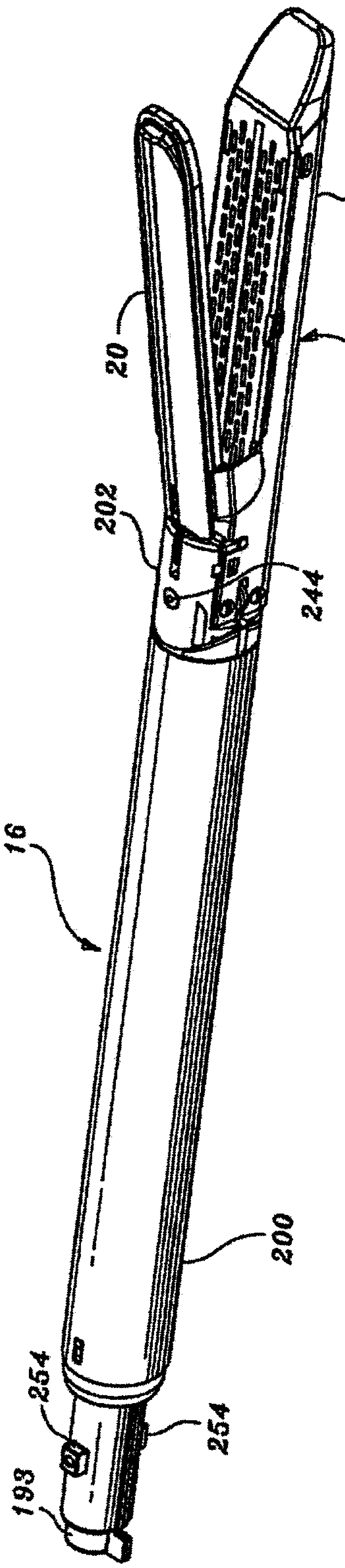

18
17
20
202
244
16
200
254
254
193

FIG. 19

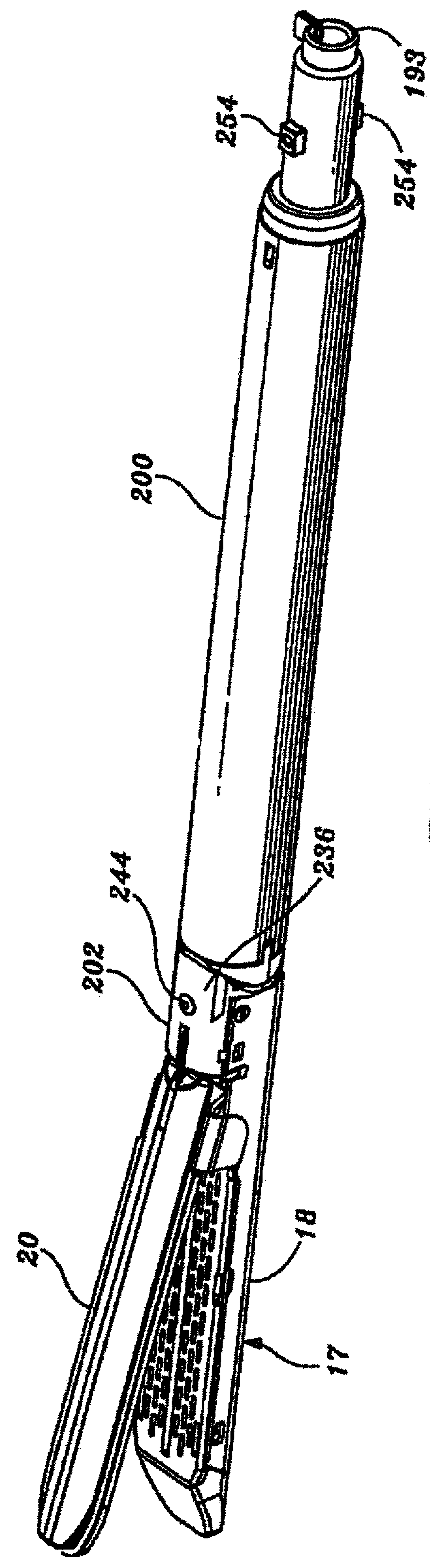

193
254
254
200
244
236
202
20
18
17

FIG. 20

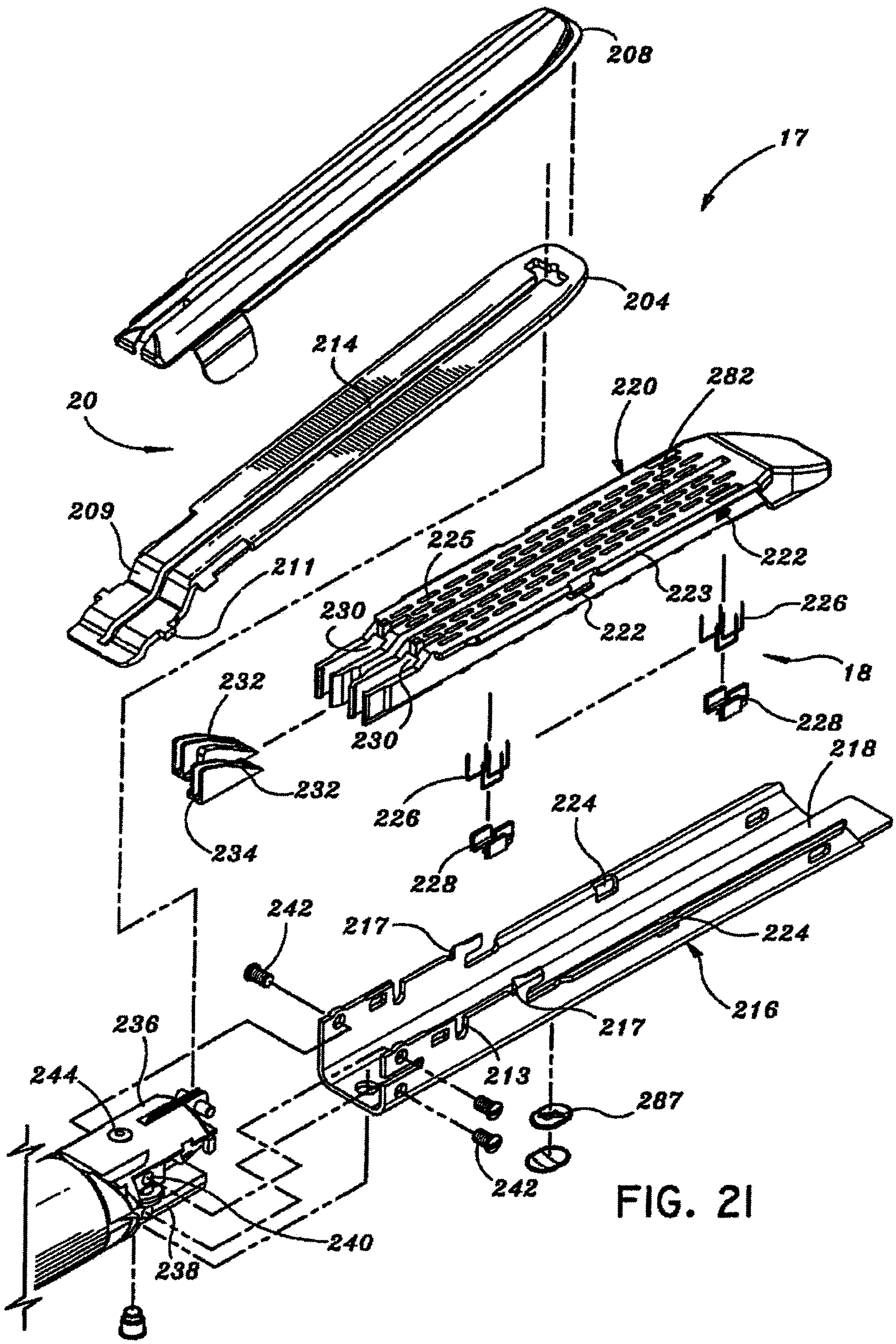

208
17
204
214
20
220
282
209
225
222
211
223
230
222
226
18
232
230
228
232
218
226
234
224
228
242
217
224
216
236
217
244
213
287
242
240
238

FIG. 21

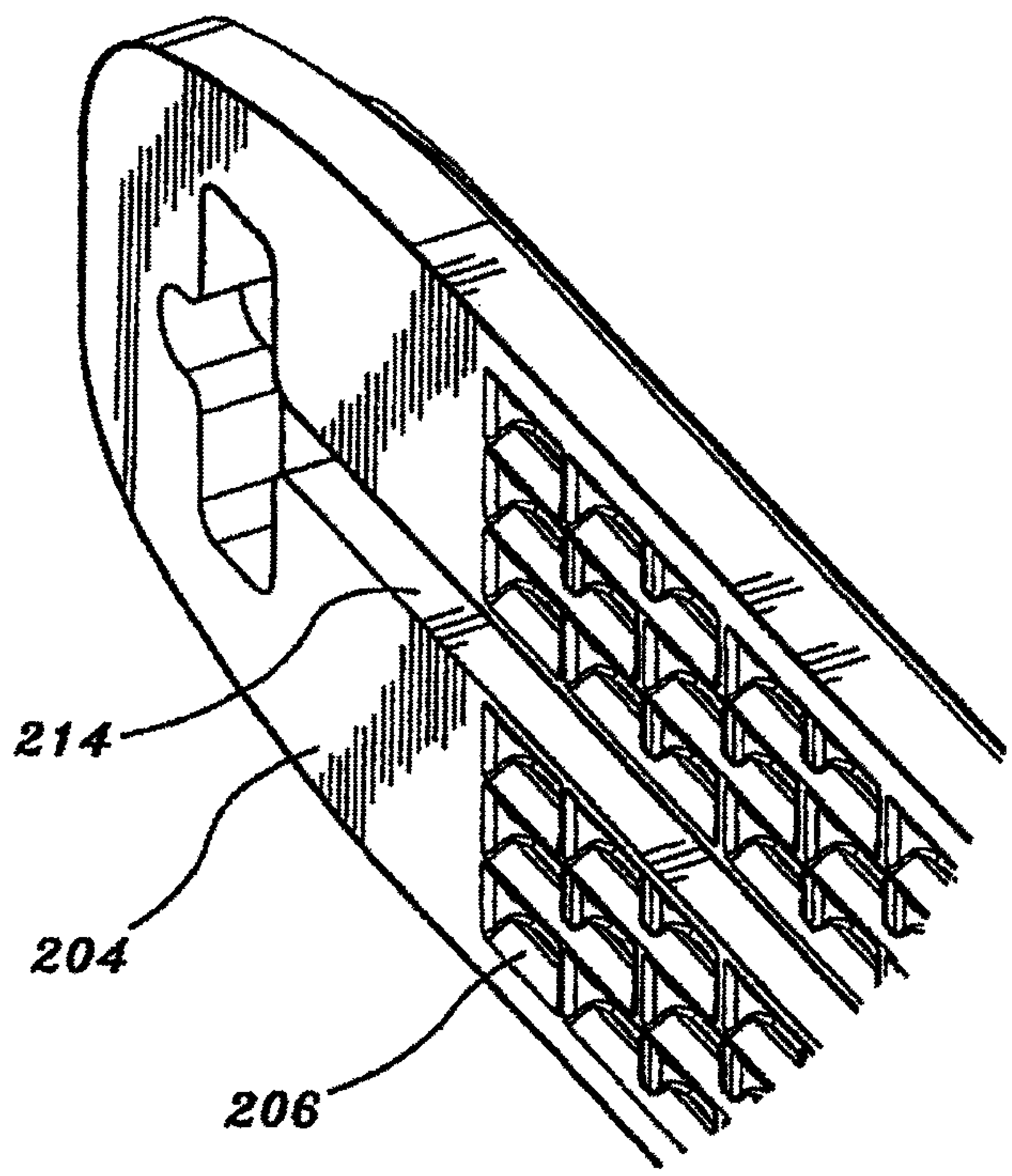


FIG. 22

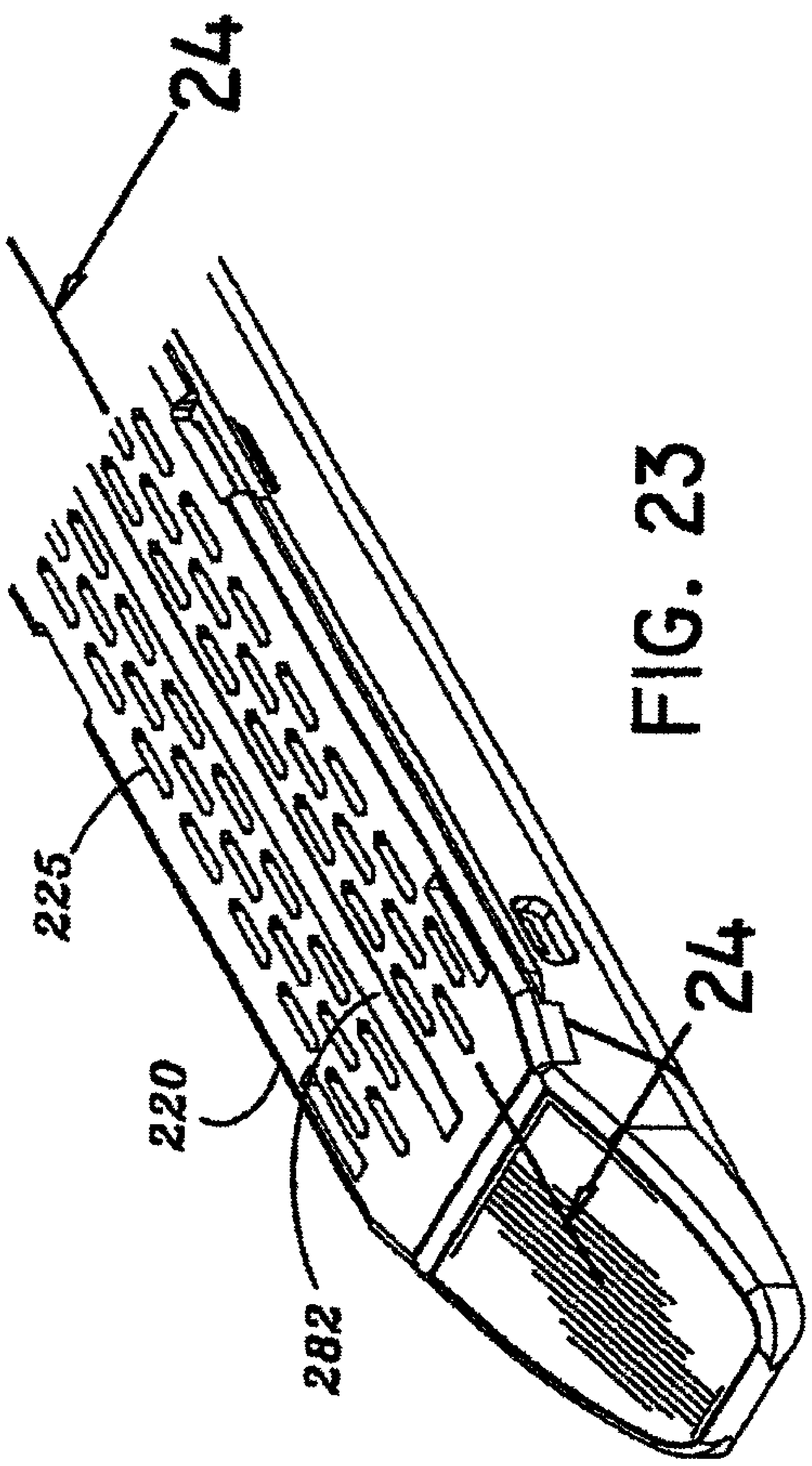

24
225
220
282
24

FIG. 23

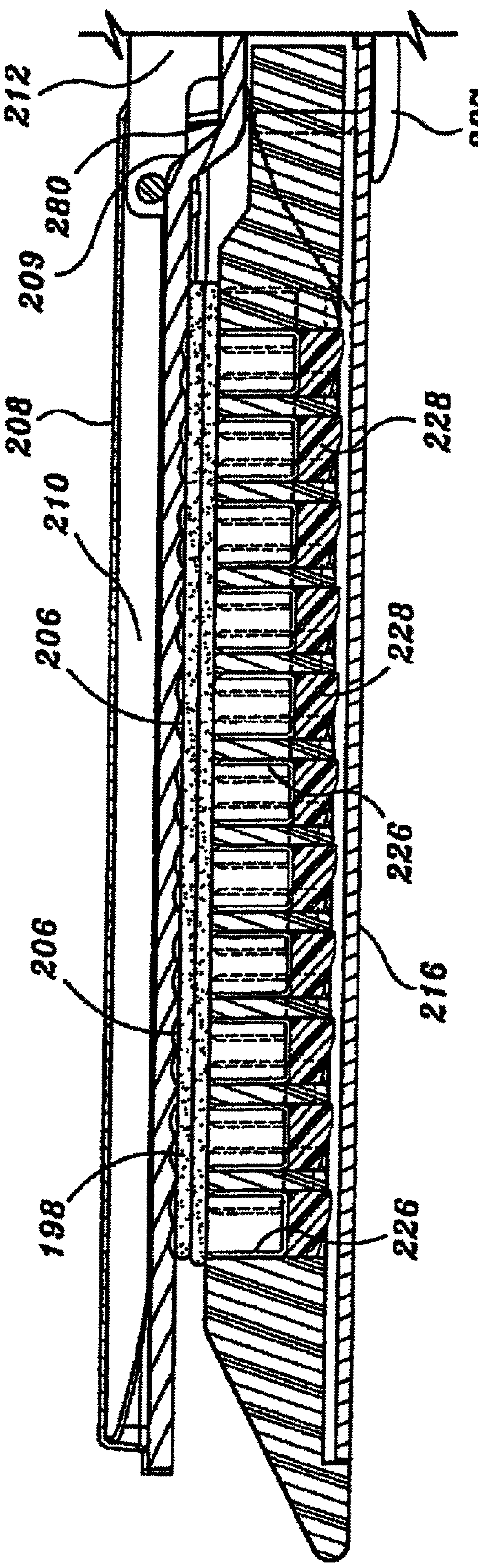

212
280
209
208
210
206
206
198
287
228
228
226
216
226

FIG. 24

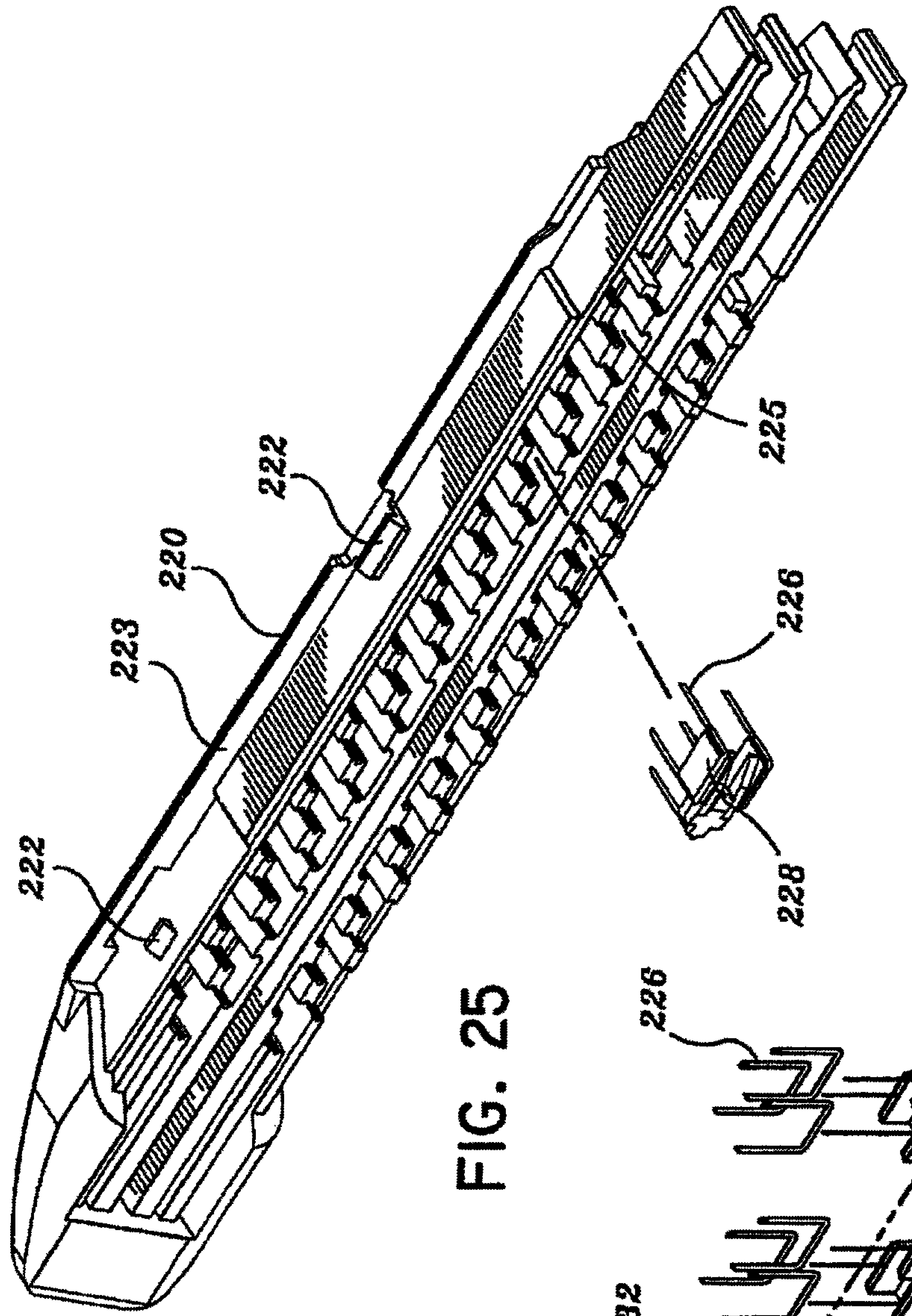


FIG. 25

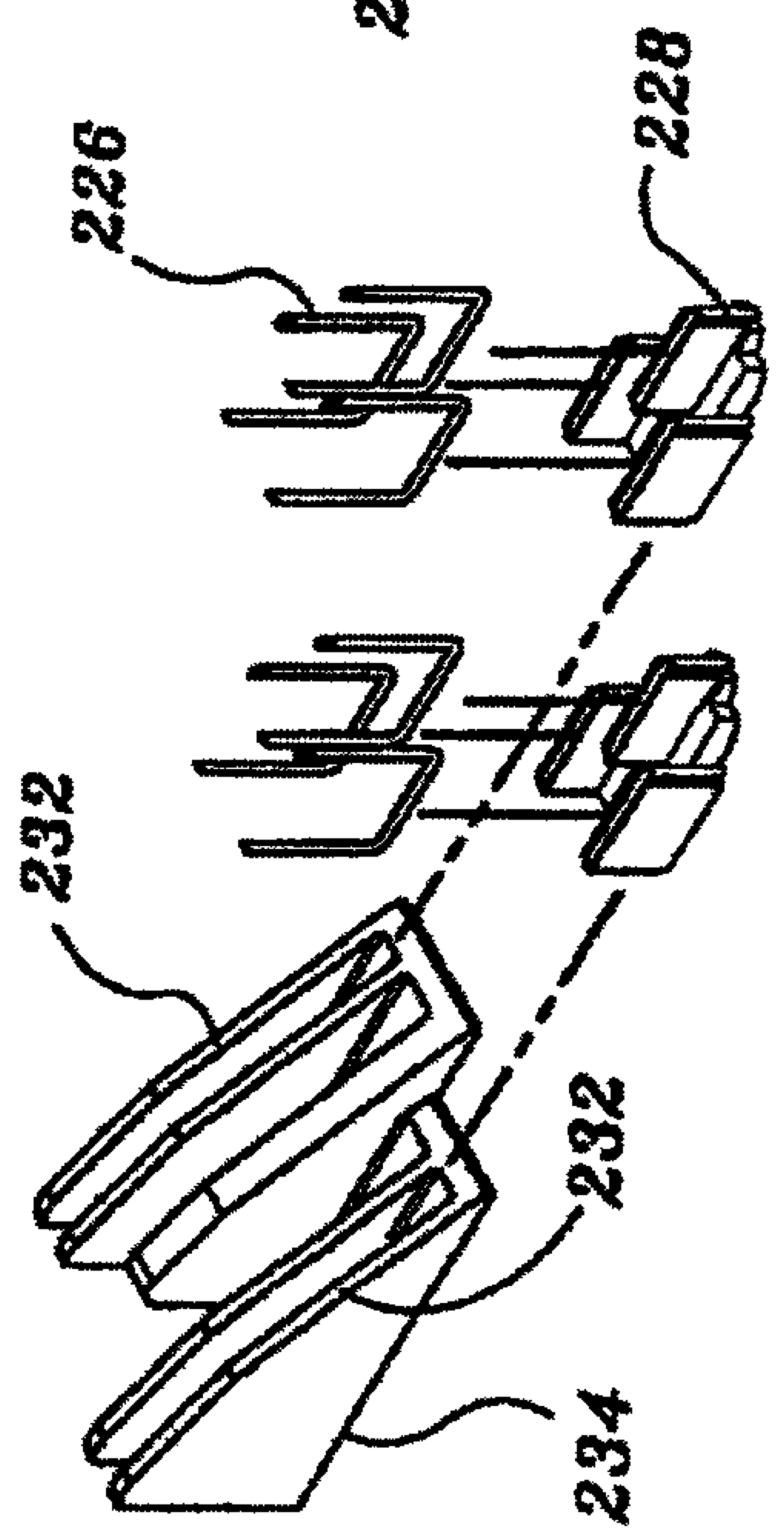
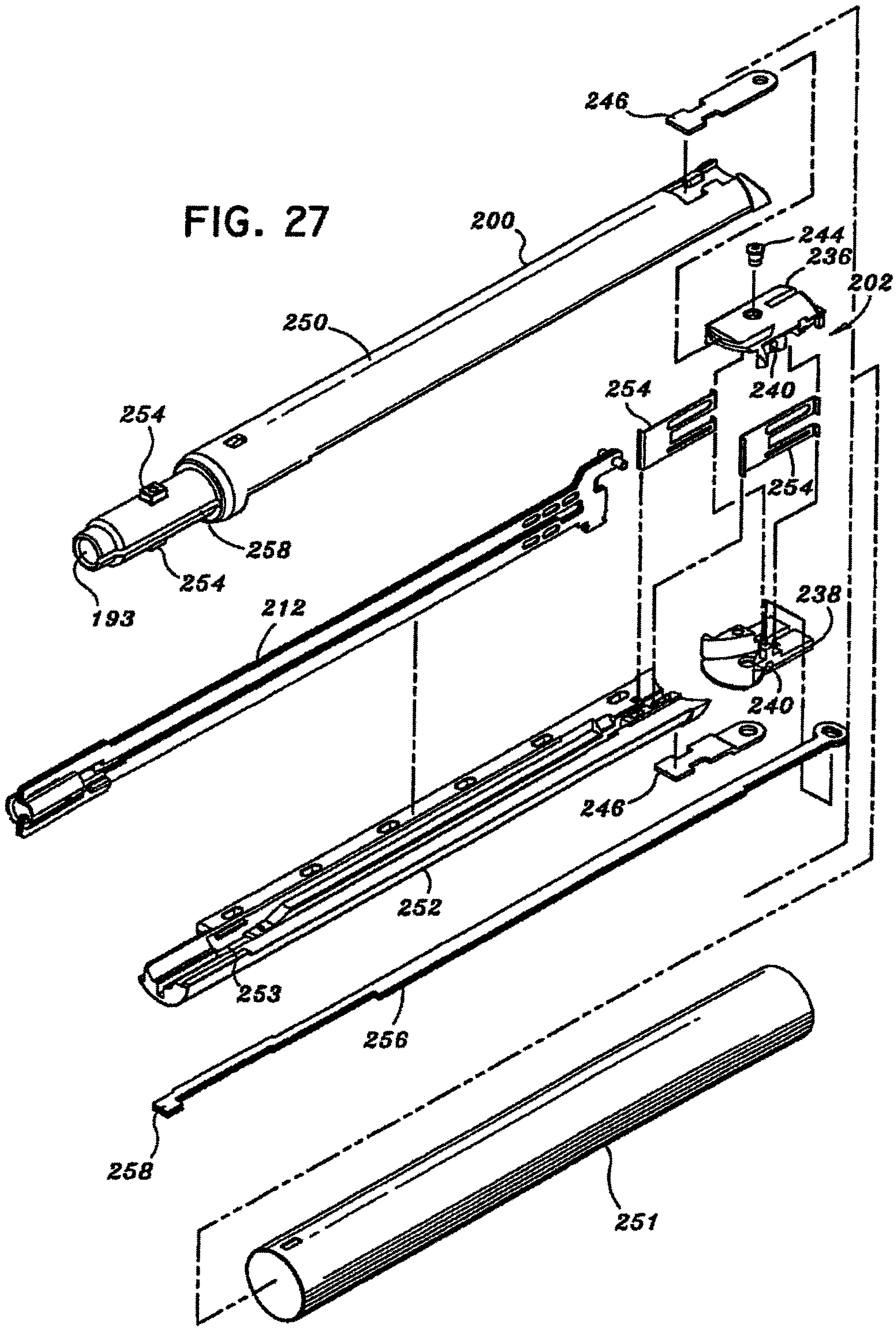


FIG. 26

FIG. 27



246
200
244
236
202
250
240
254
254
254
258
254
193
212
238
240
246
252
253
256
258
251

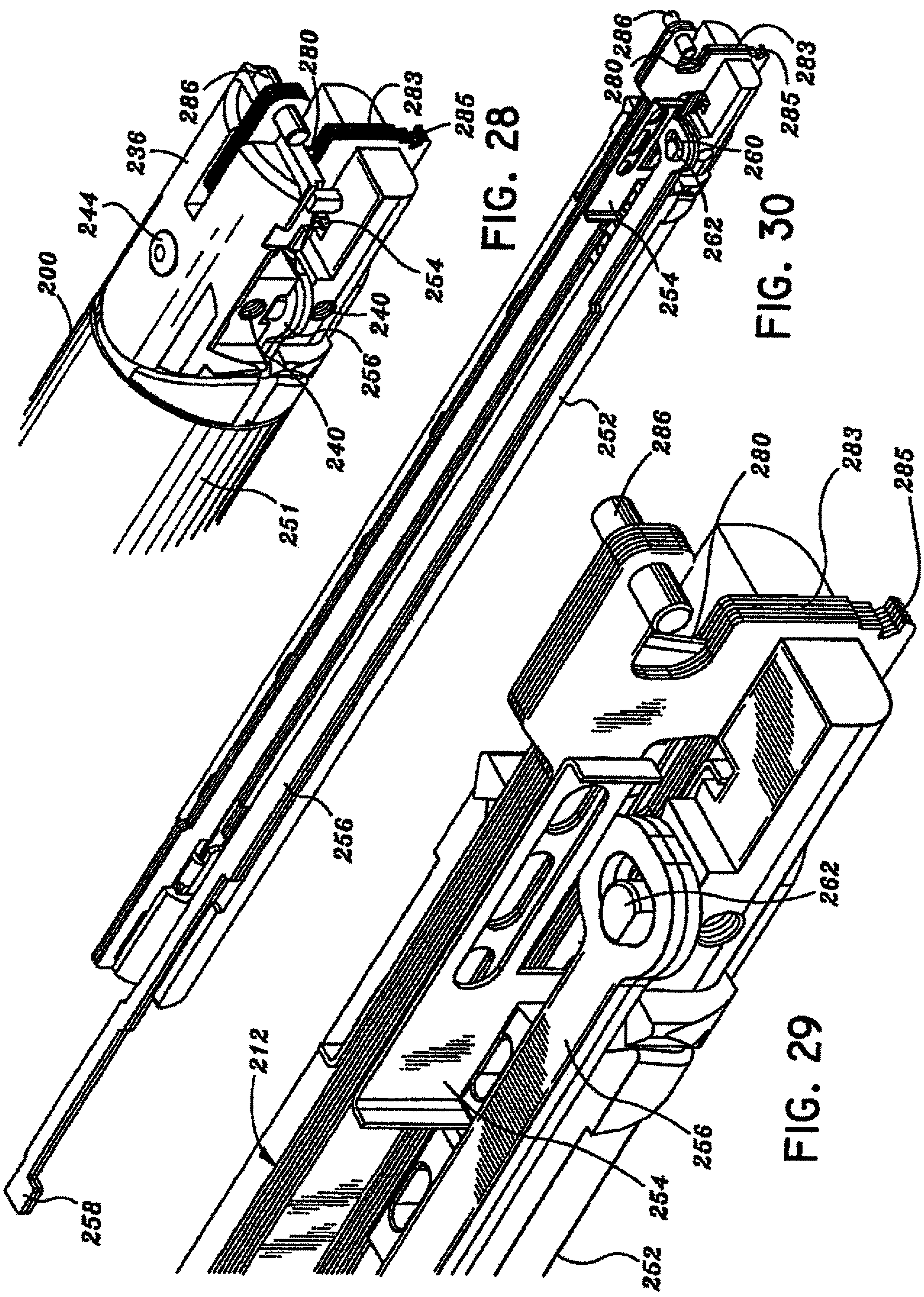
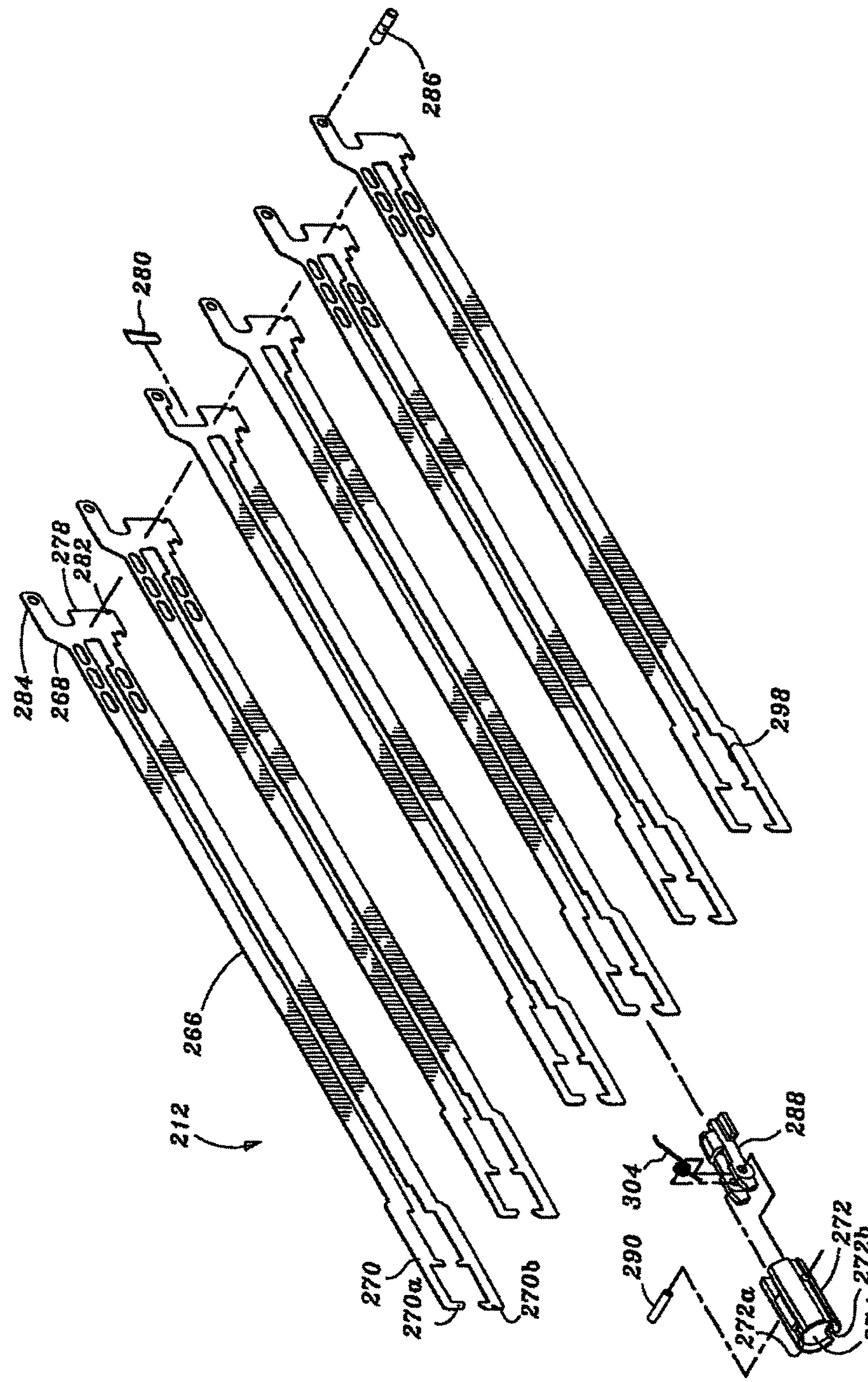


FIG. 28

FIG. 29

FIG. 30



284
268
278
282
280
286
266
212
270
270a
270b
298
288
304
290
272
272a
272b
274

FIG. 31

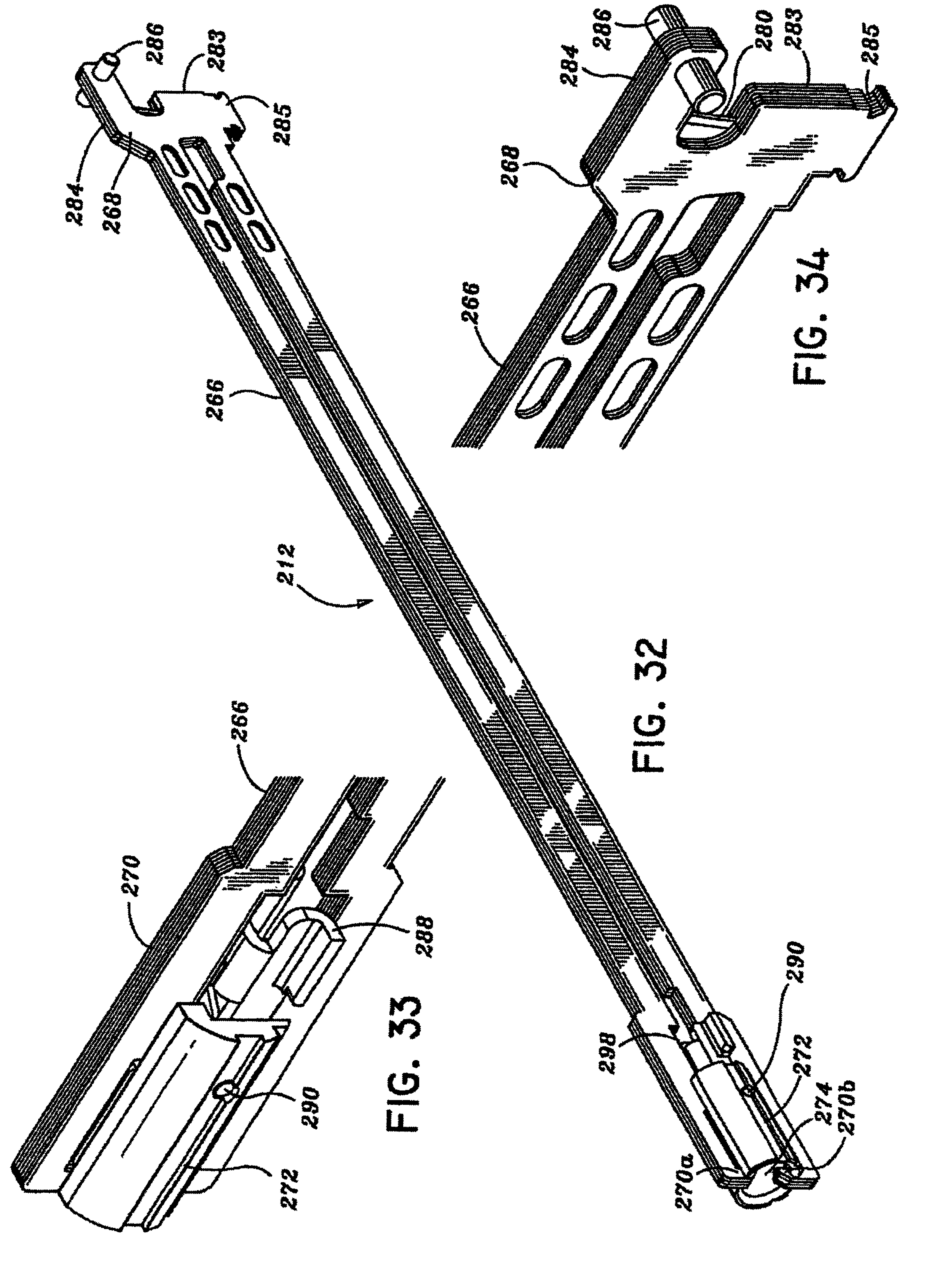


FIG. 32

FIG. 33

FIG. 34

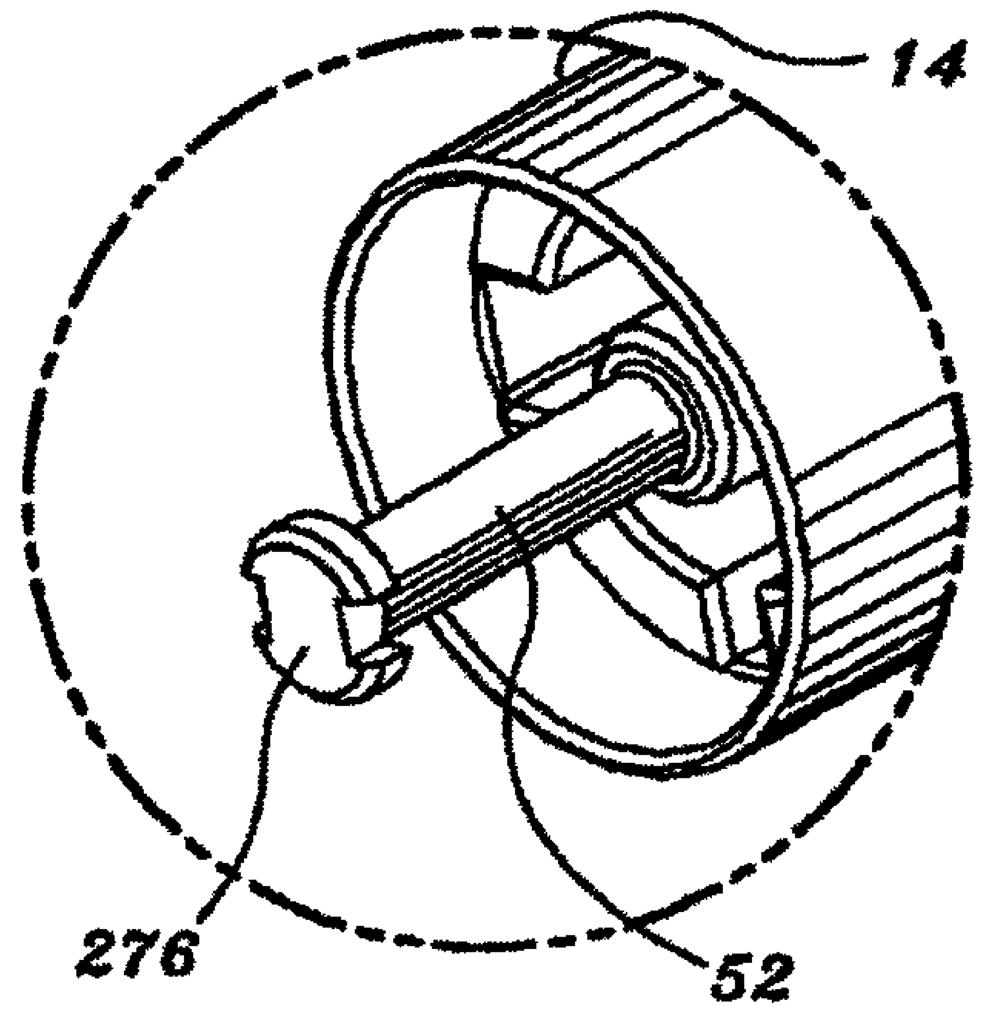


FIG. 35

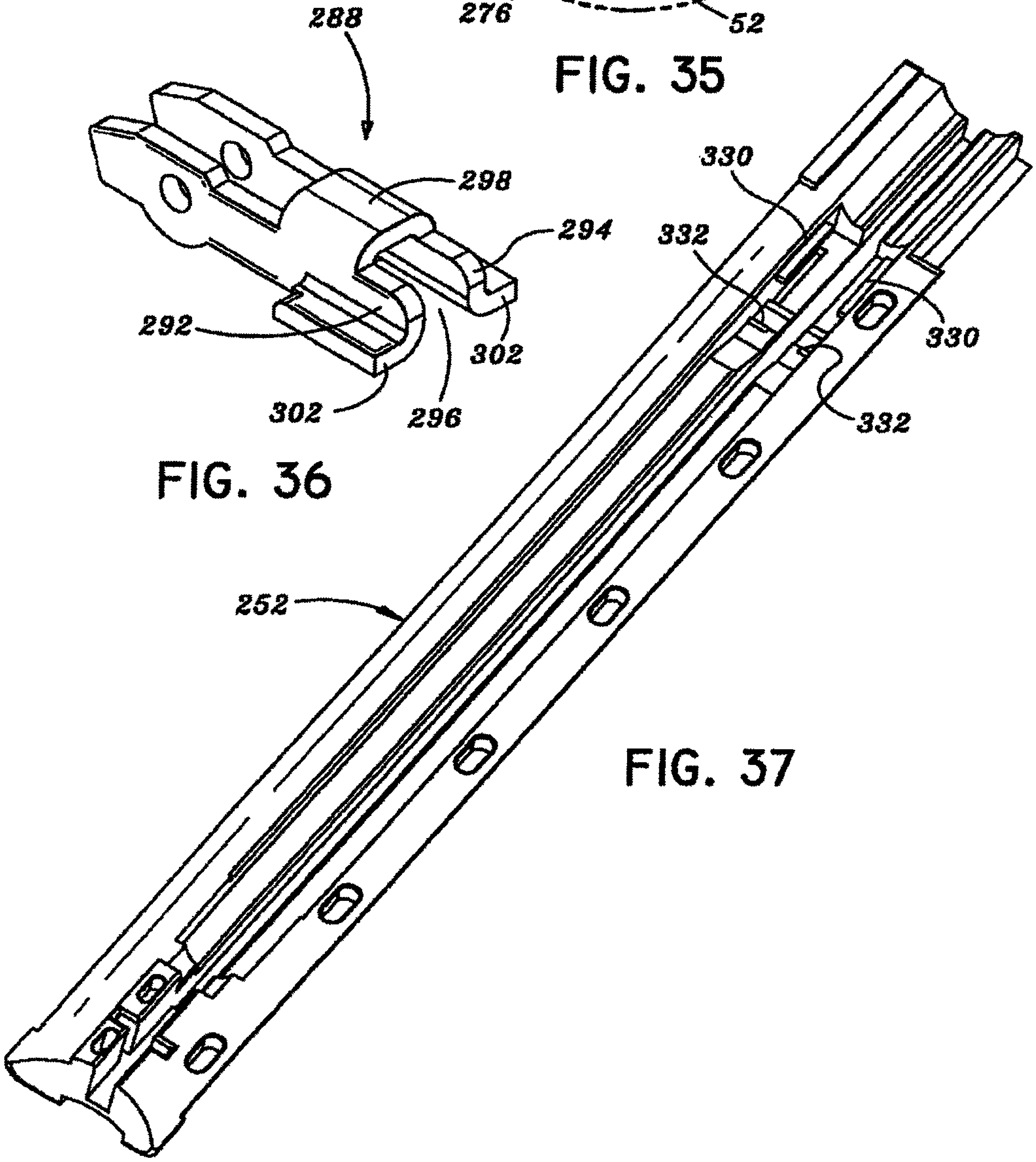


FIG. 36

FIG. 37

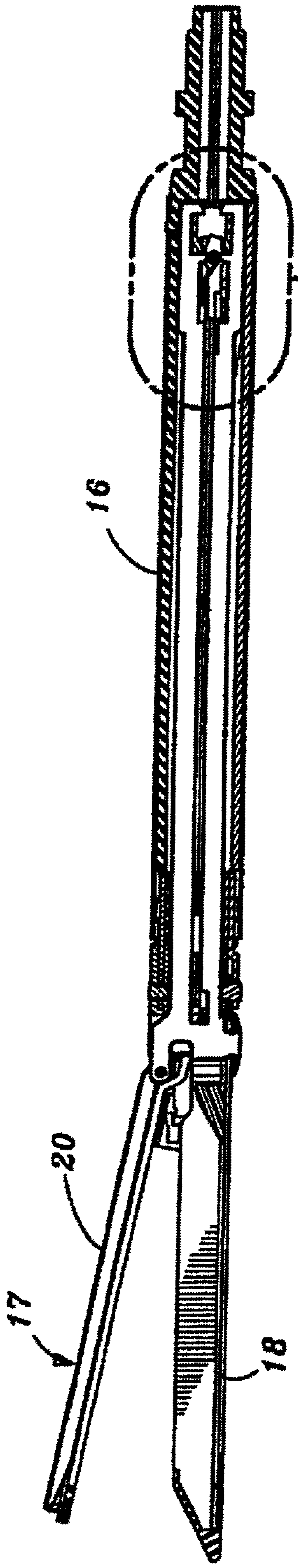


FIG. 38

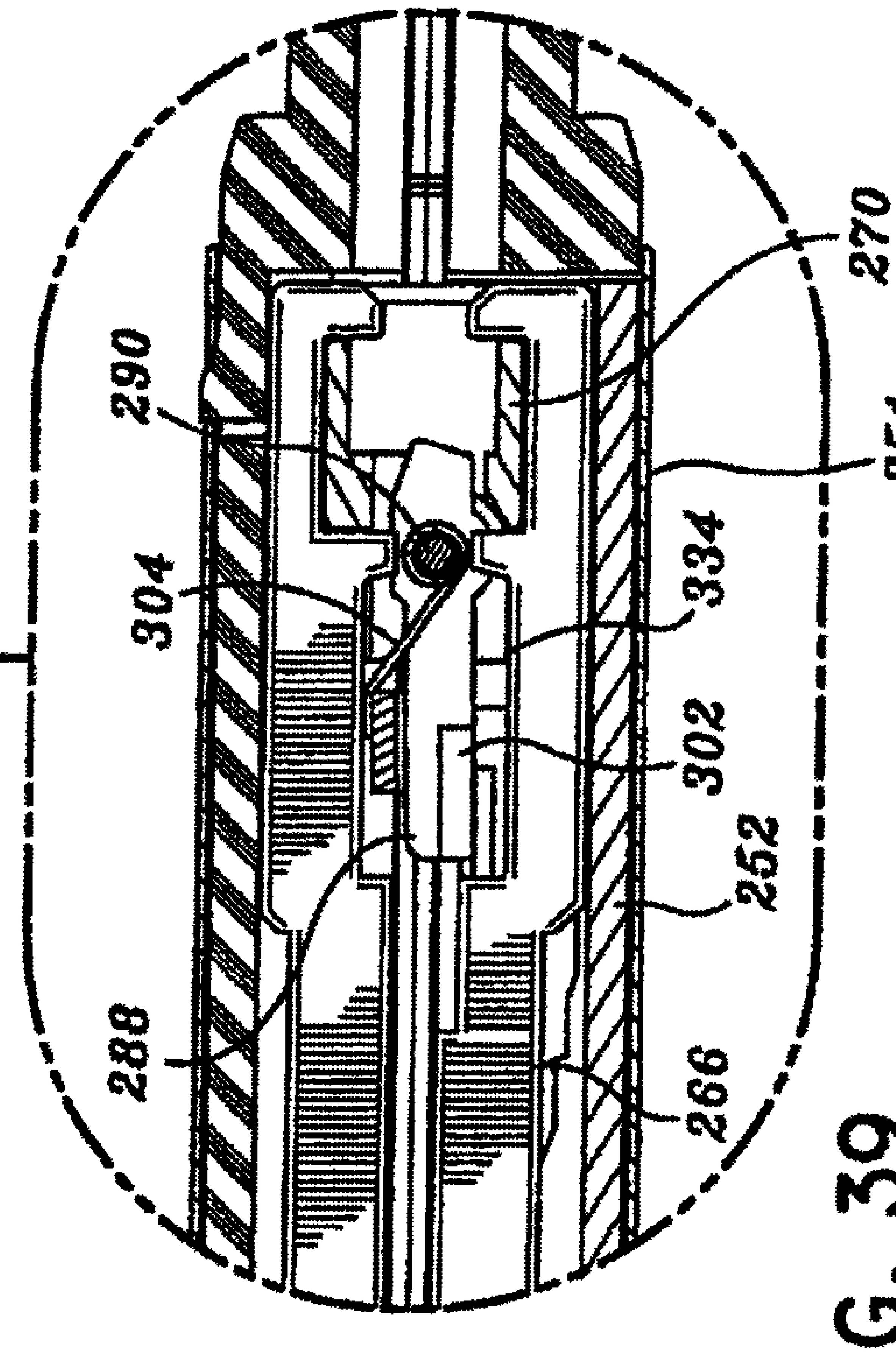


FIG. 39

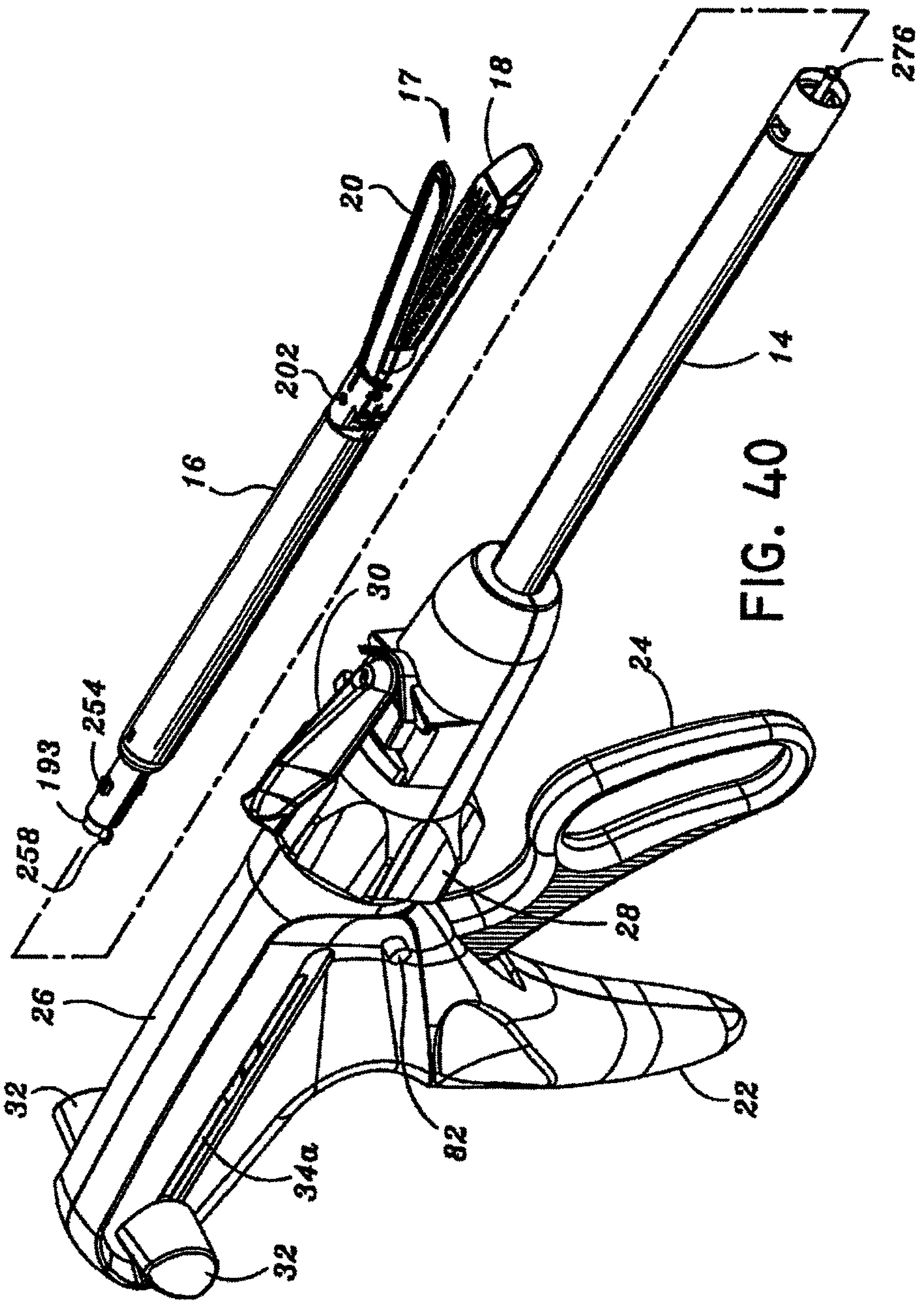


FIG. 40

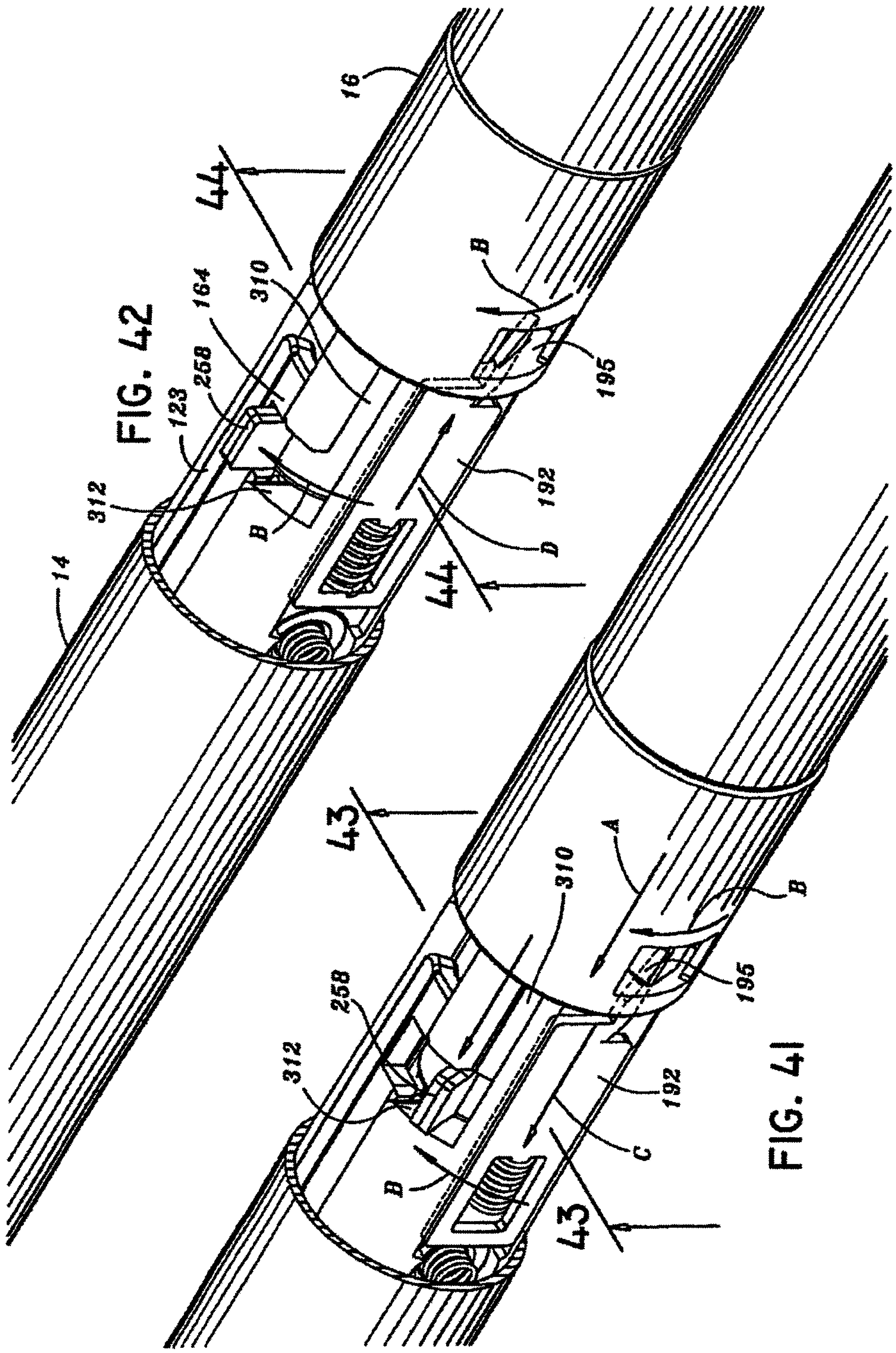
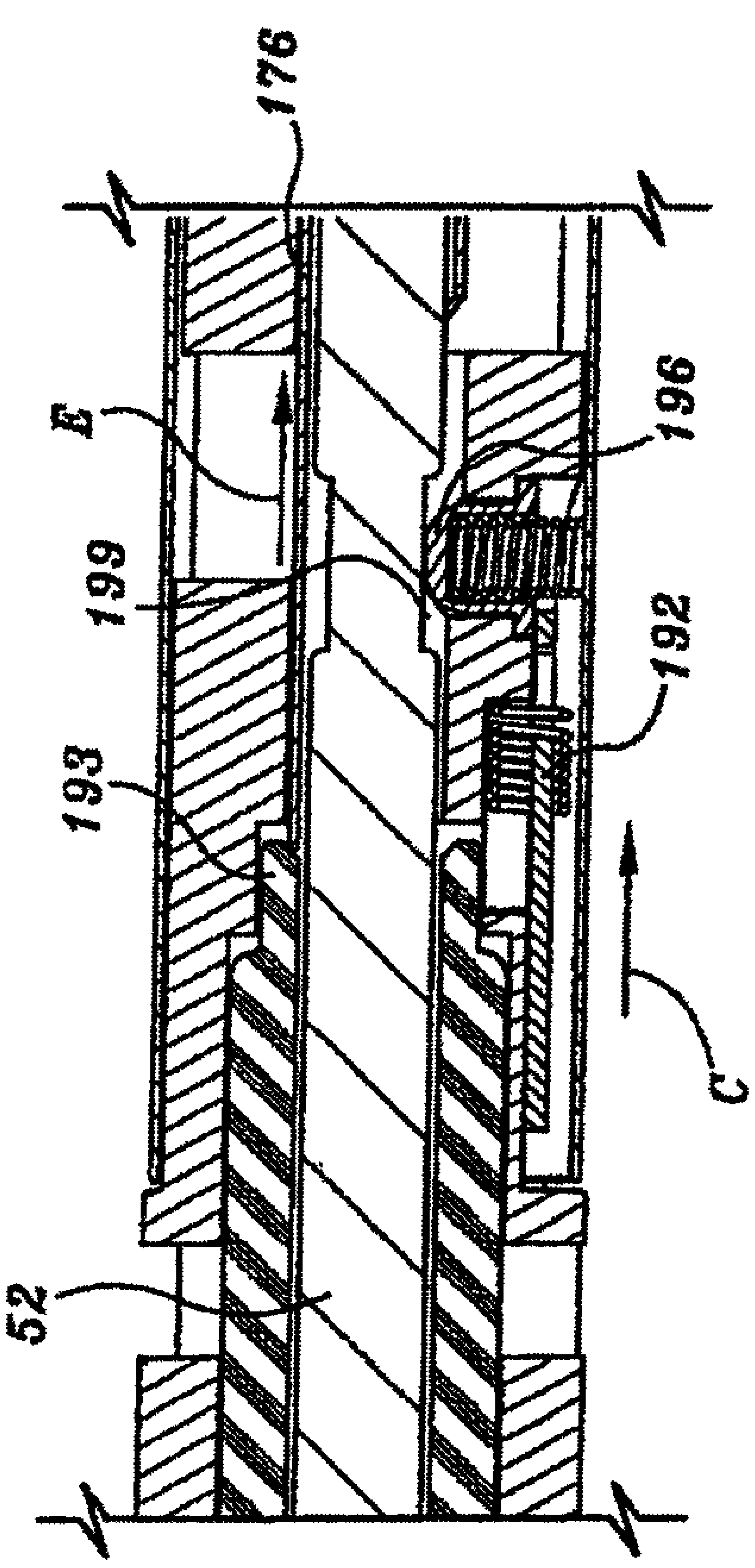

16
44
B
310
164
258
123
312
B
14
195
192
D
44
43
310
A
B
195
258
312
192
C
B
43

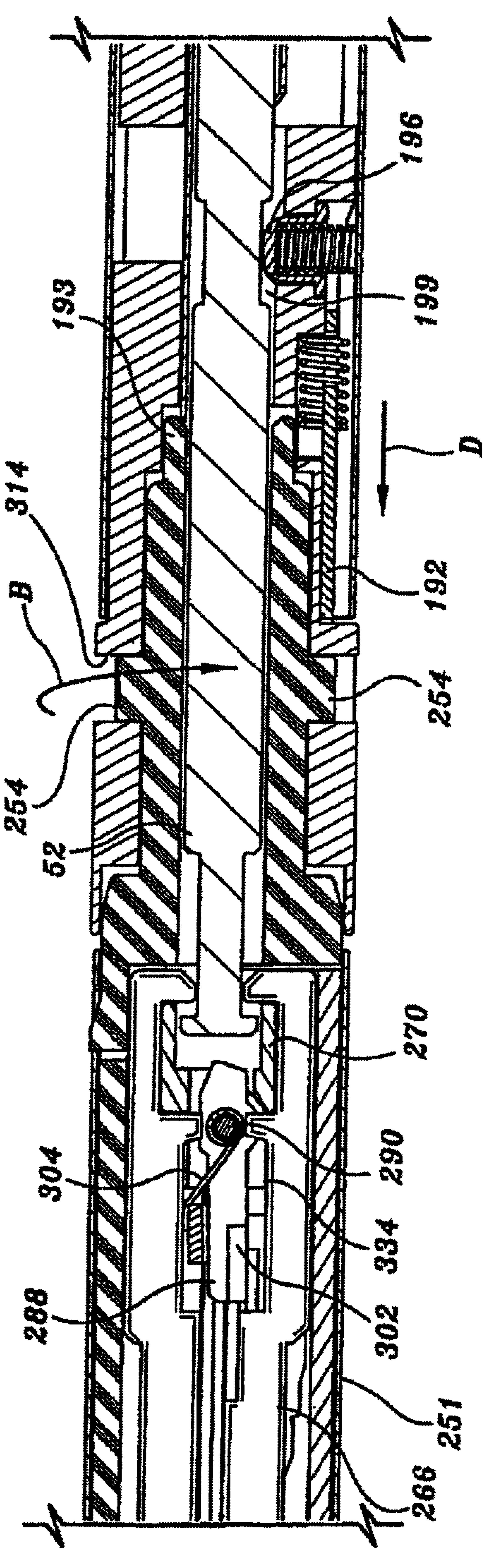
FIG. 42

FIG. 41



176
E
196
199
192
193
52
C

FIG. 43



196
193
199
314
D
B
192
254
254
52
270
290
304
334
288
302
251
266

FIG. 44

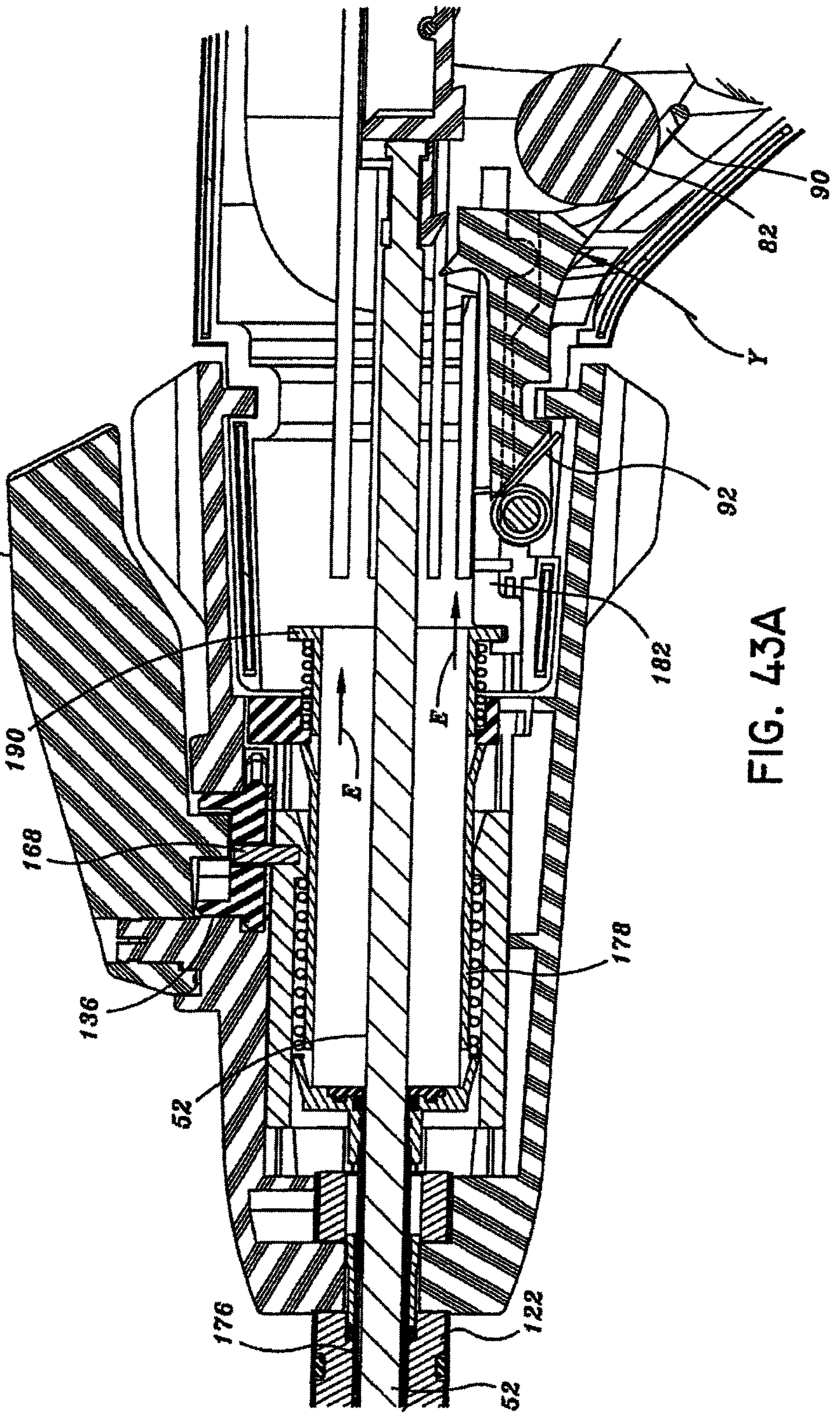


FIG. 43A

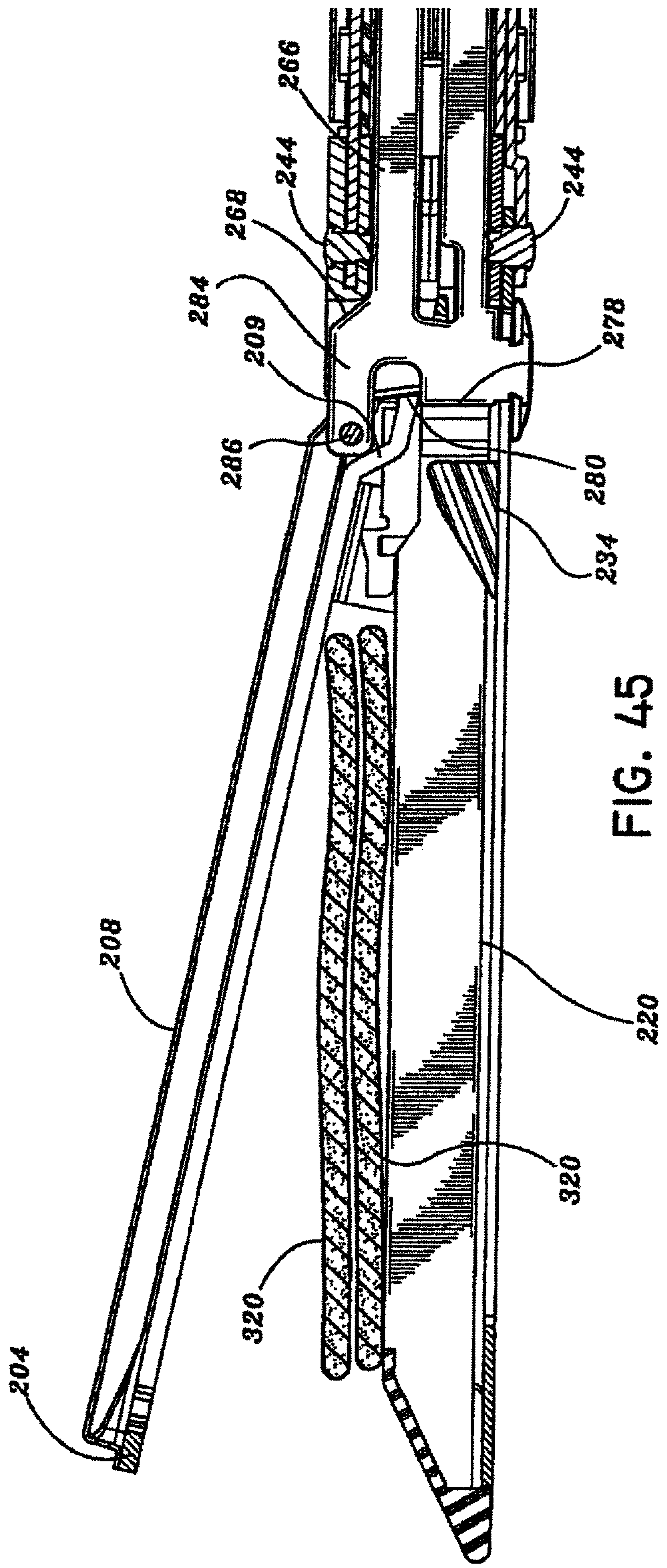


FIG. 45

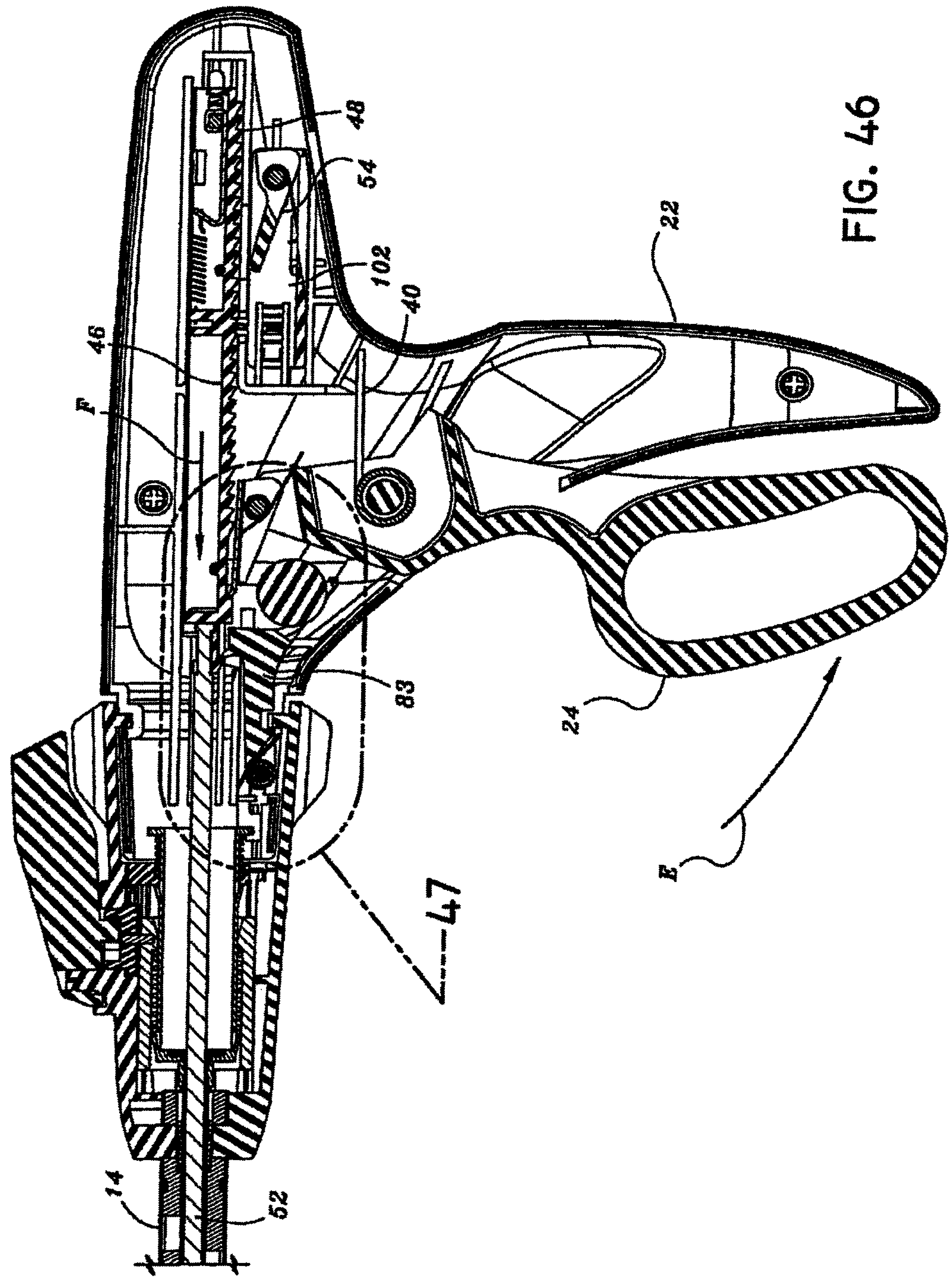


FIG. 46

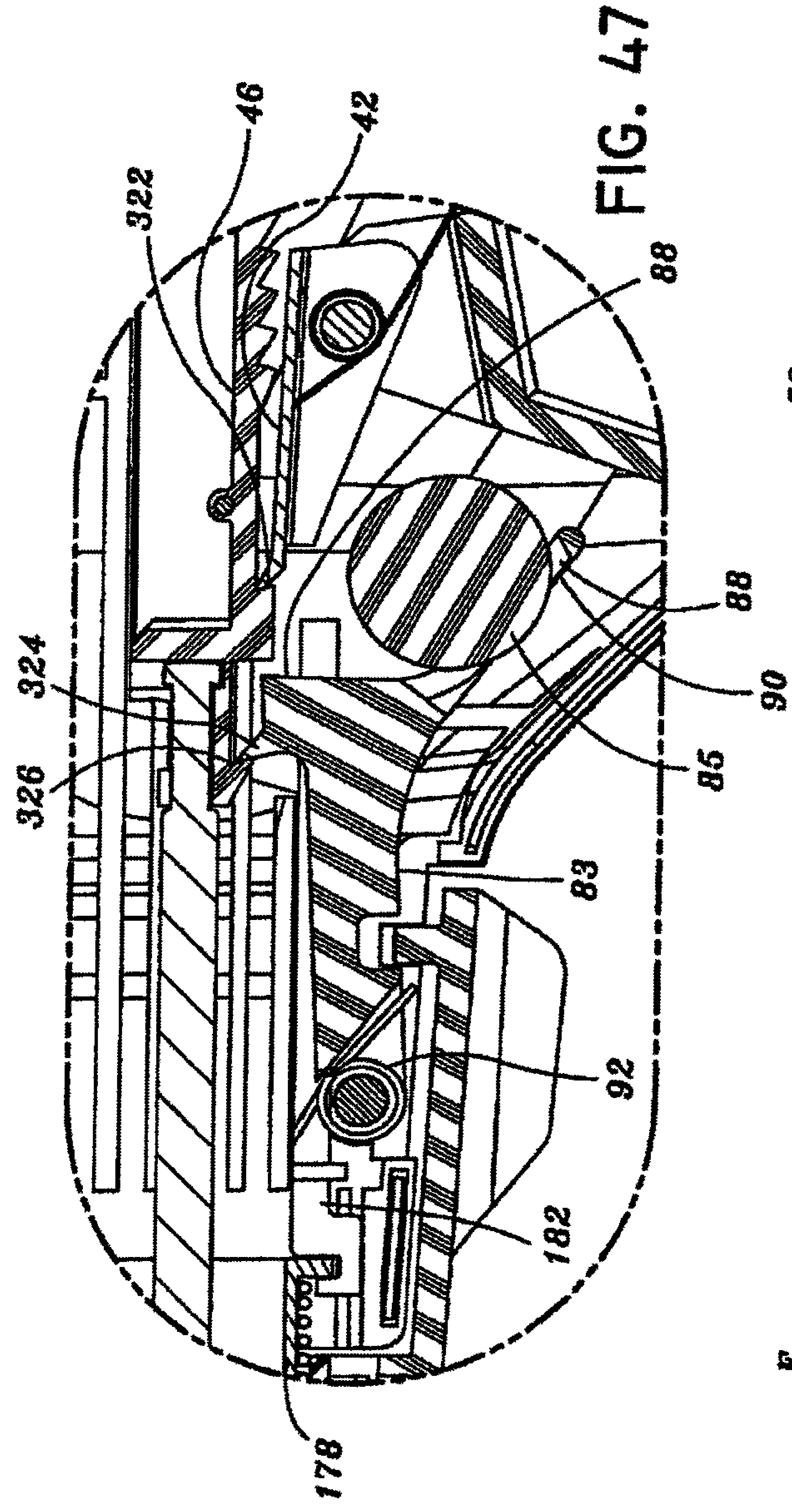


FIG. 47

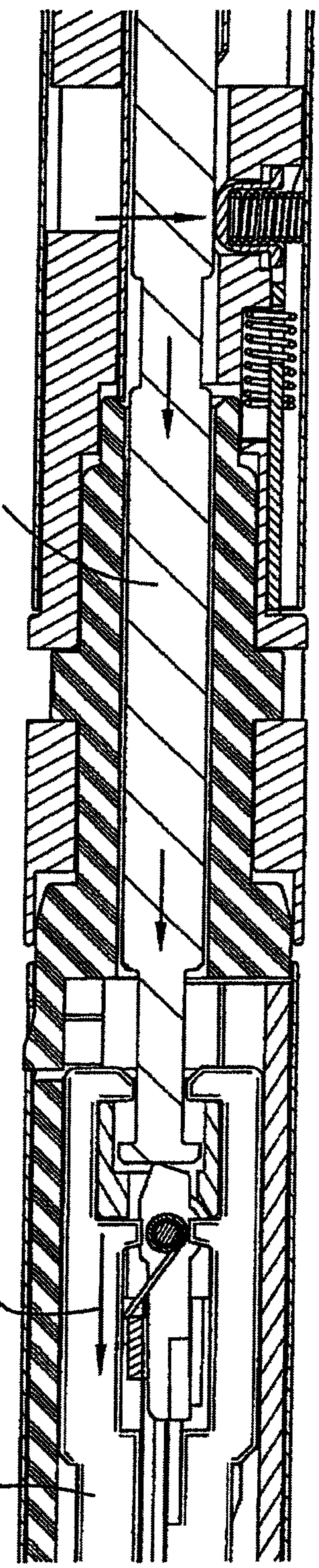


FIG. 48

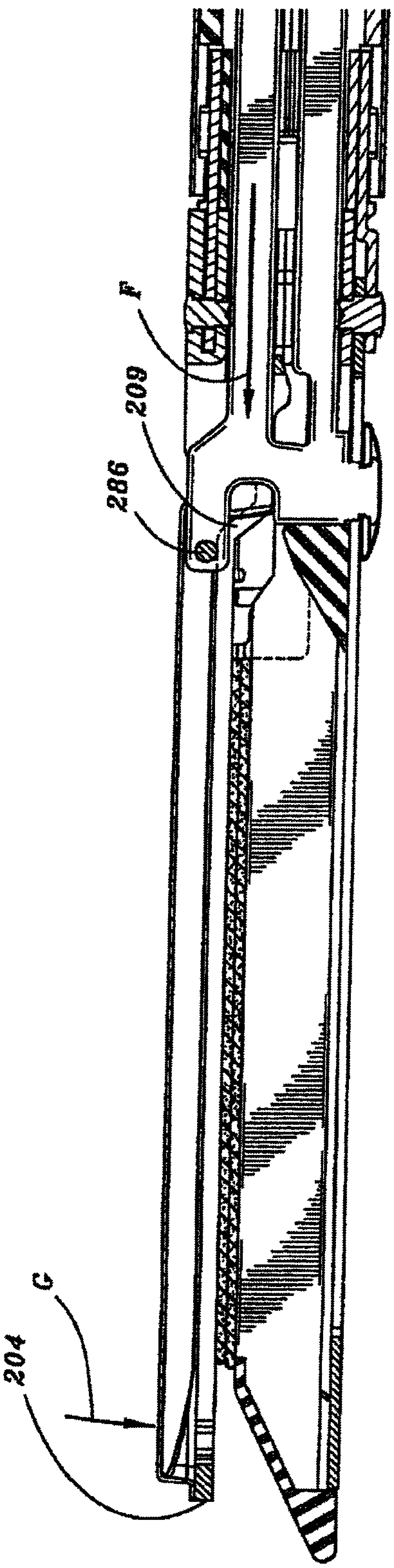


FIG. 49

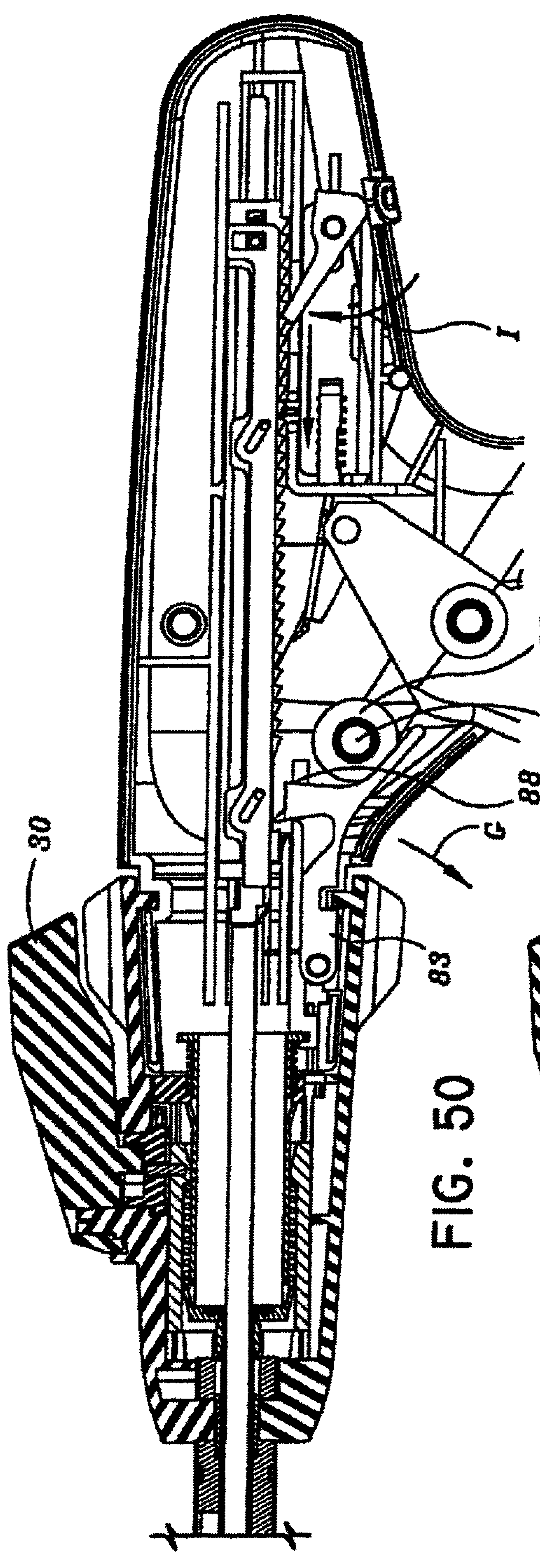


FIG. 50

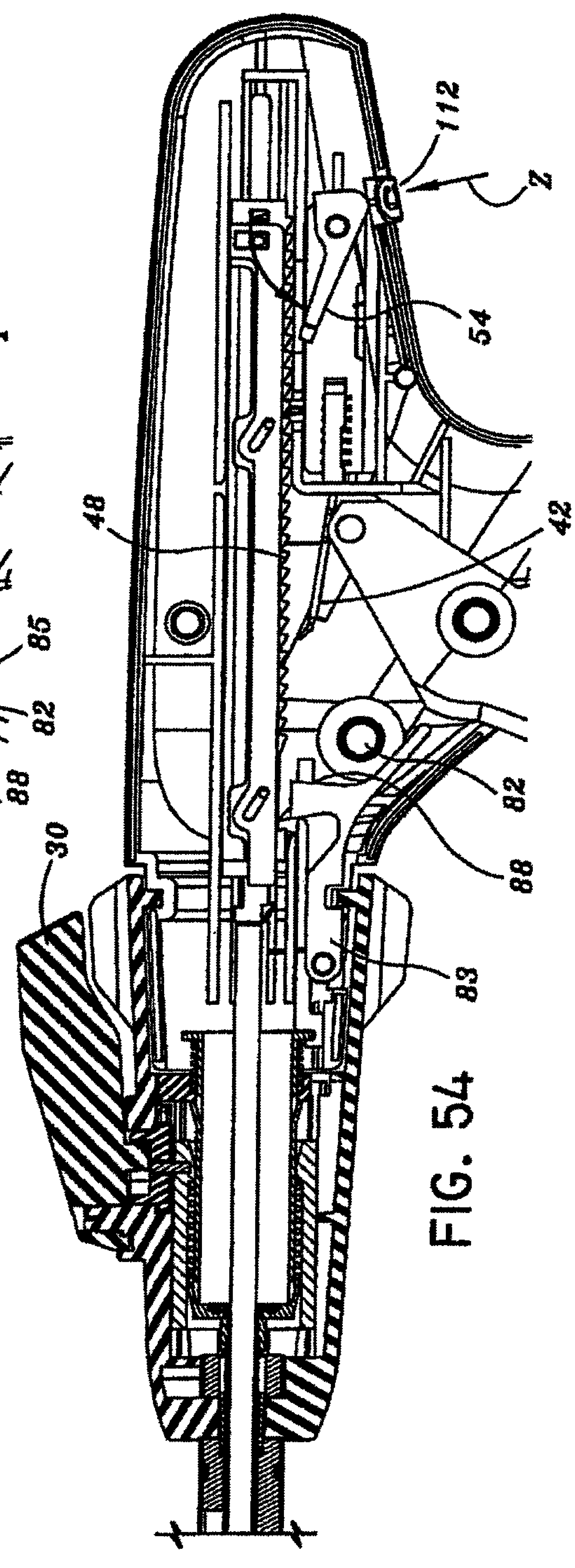


FIG. 54

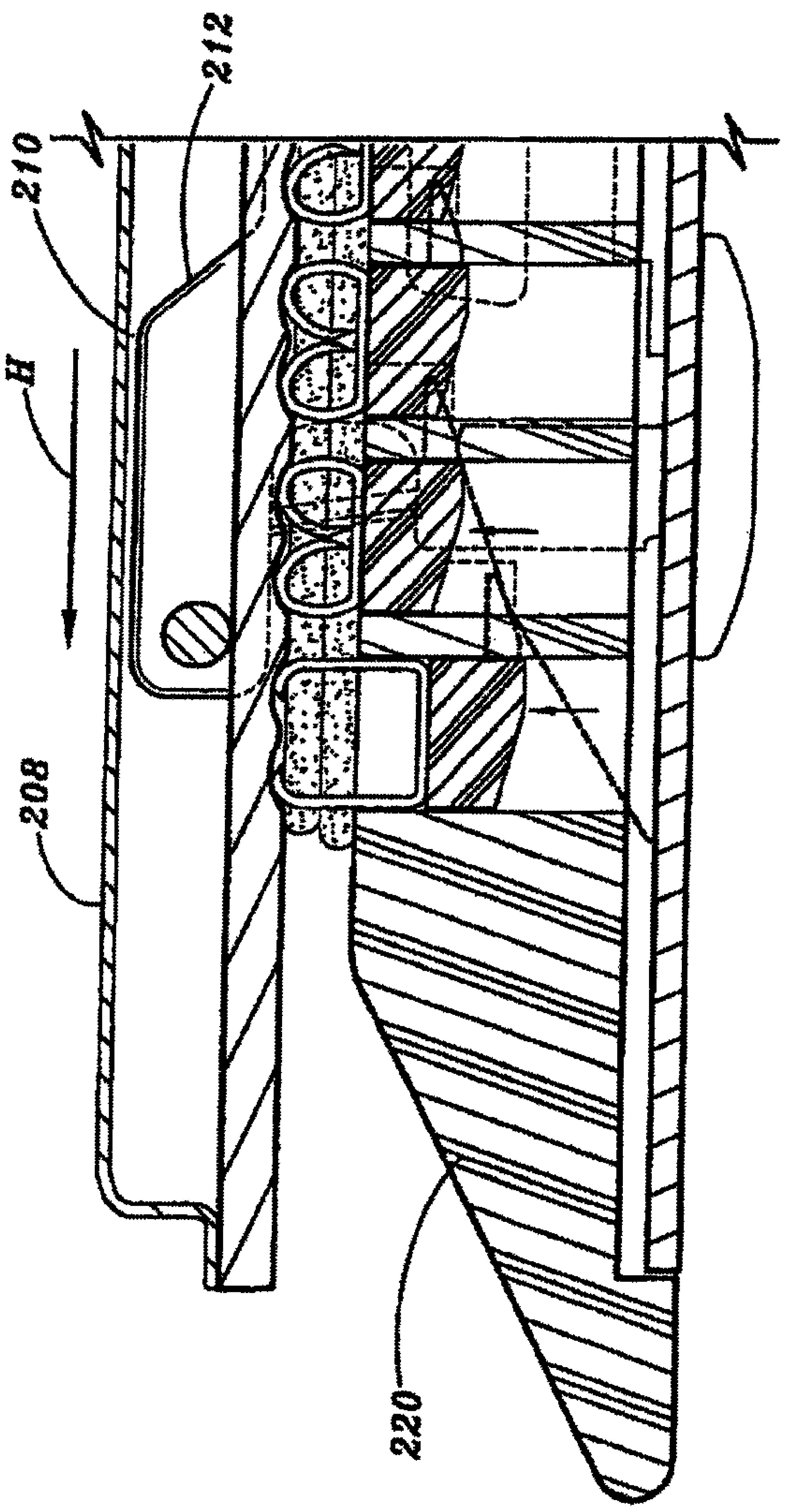


FIG. 51

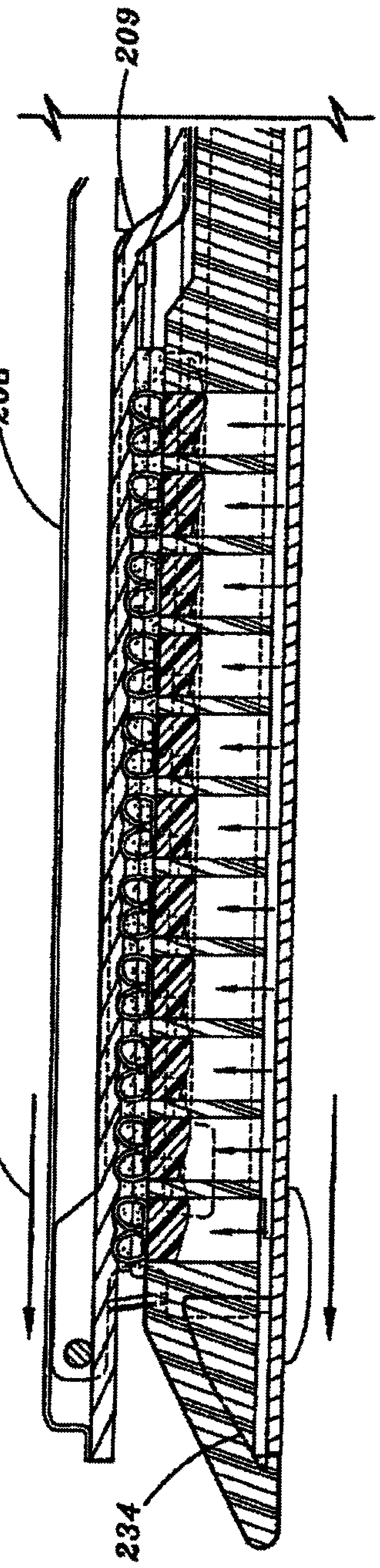


FIG. 52

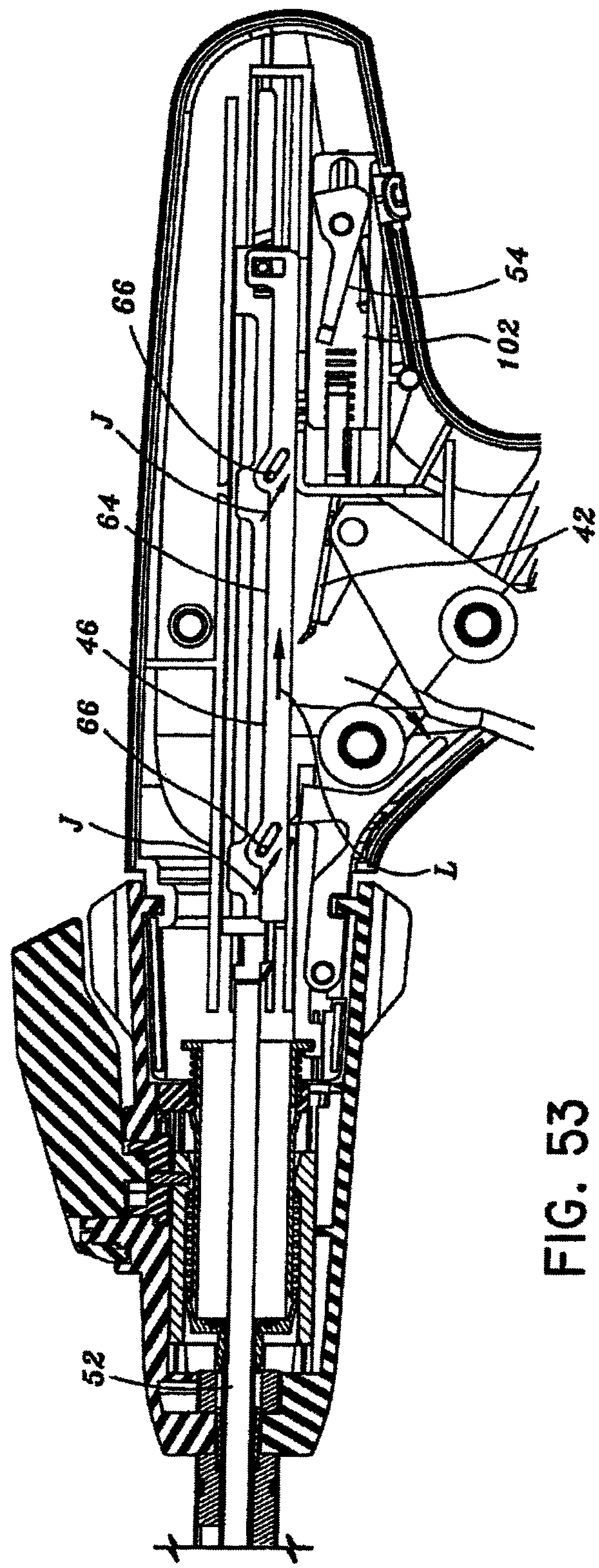


FIG. 53

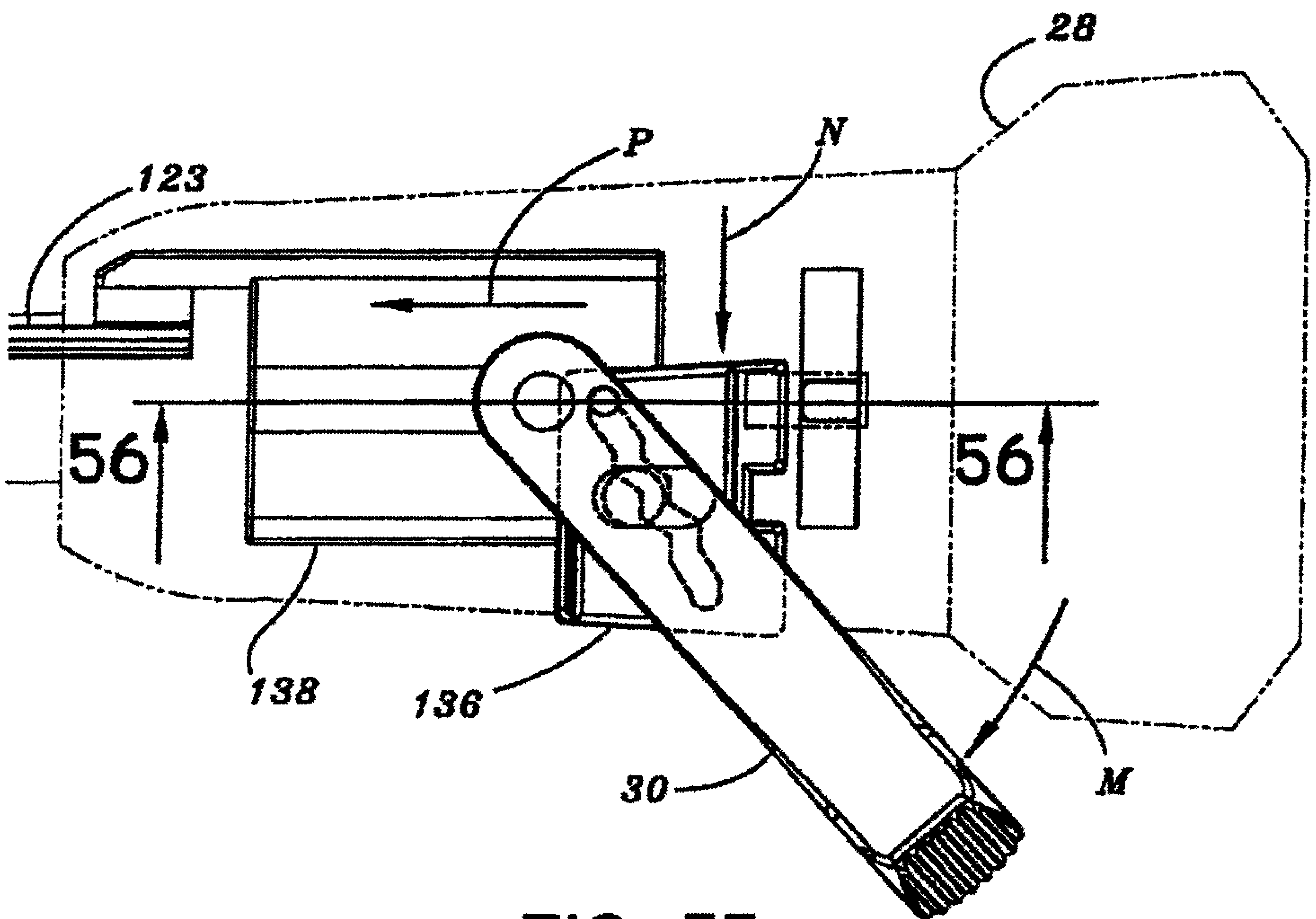


FIG. 55

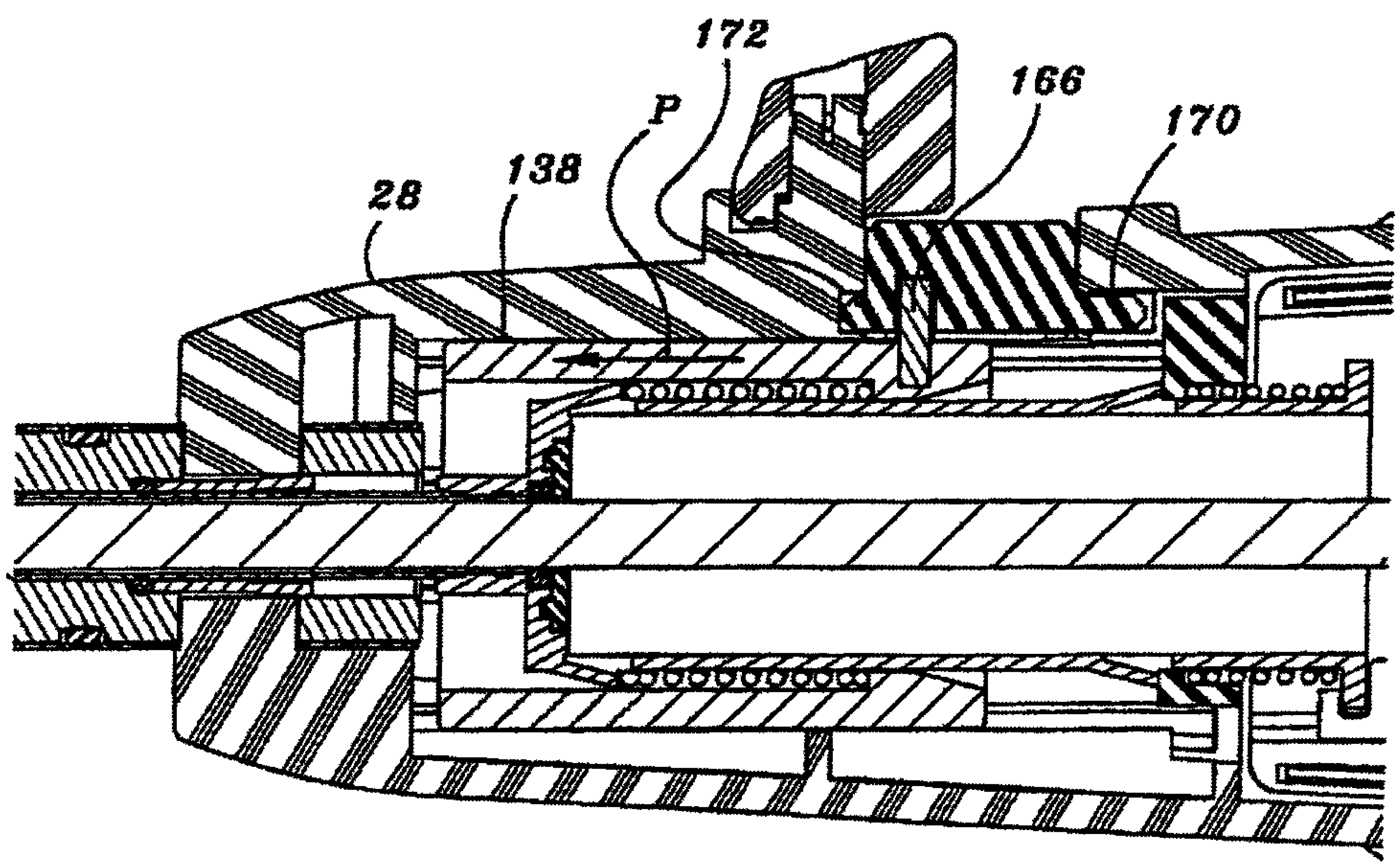


FIG. 56

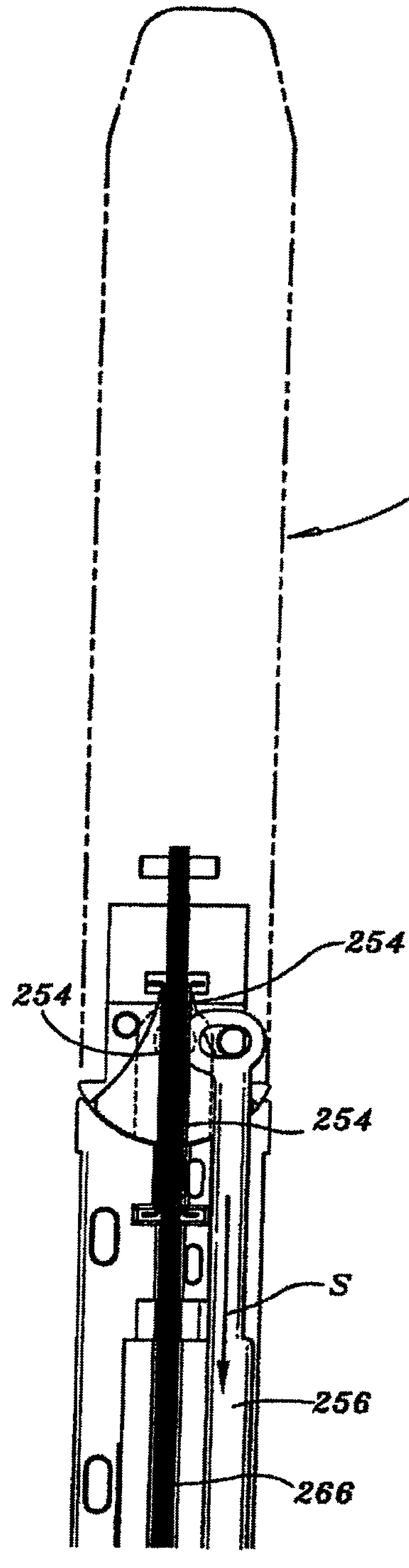


FIG. 60

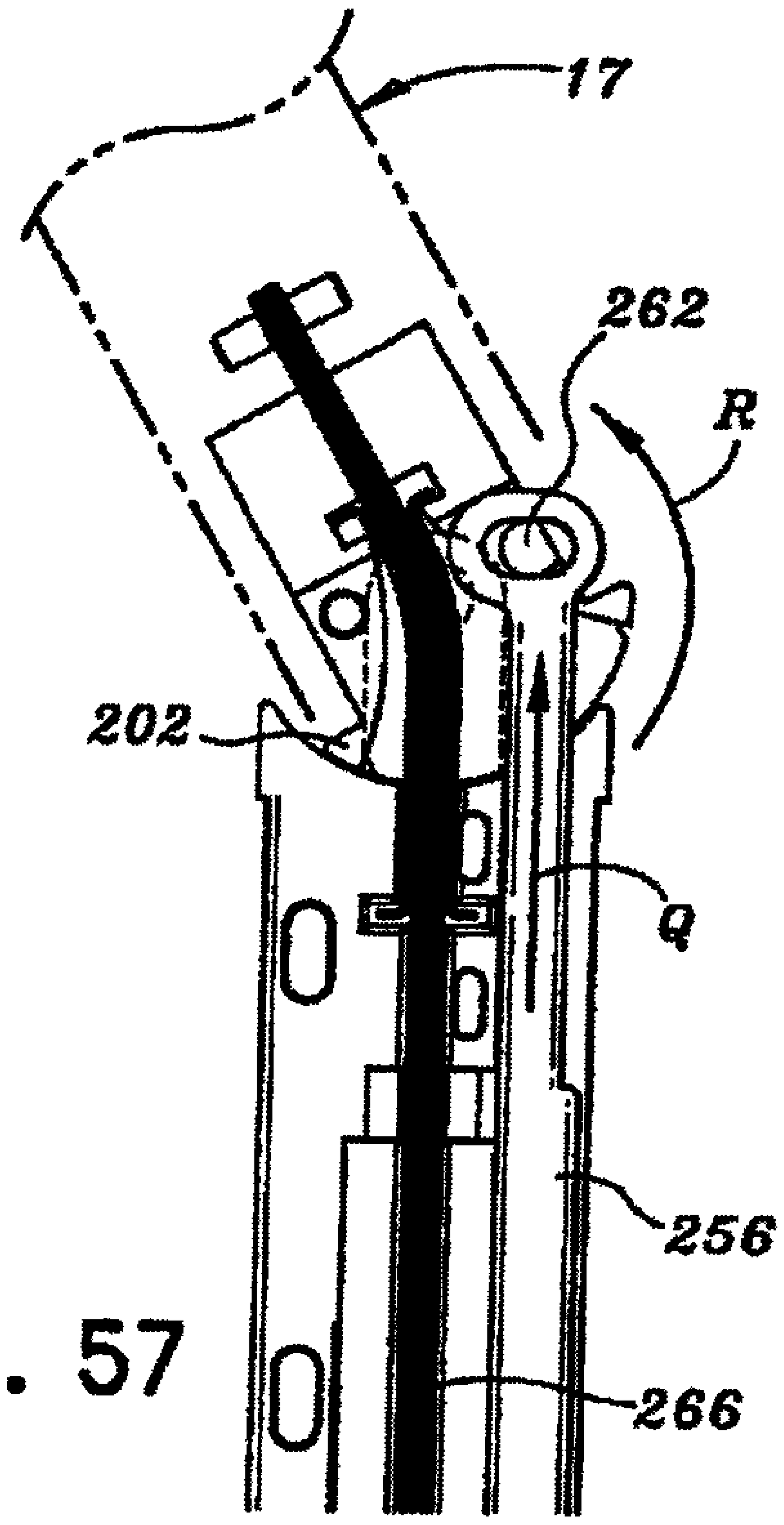


FIG. 57

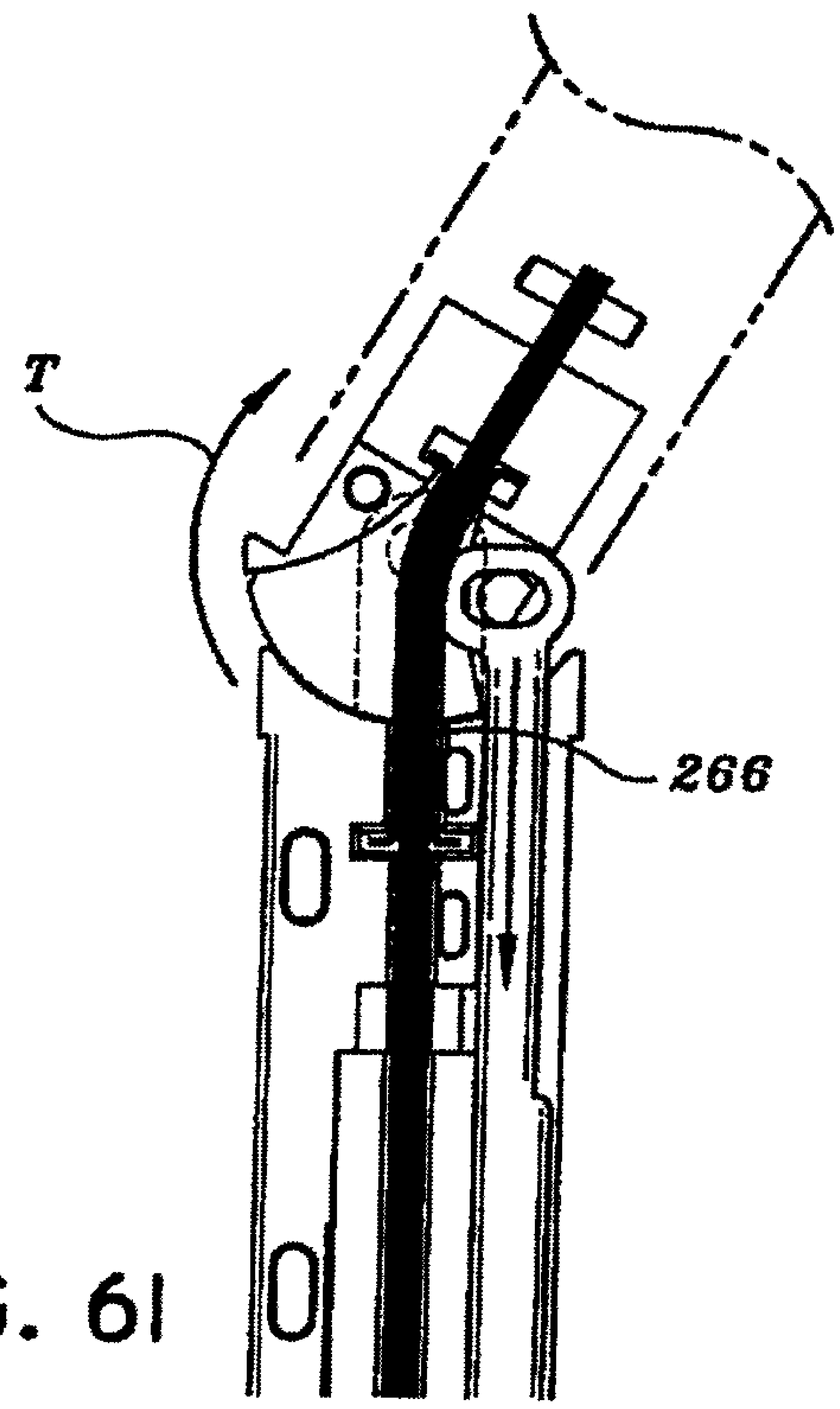


FIG. 61

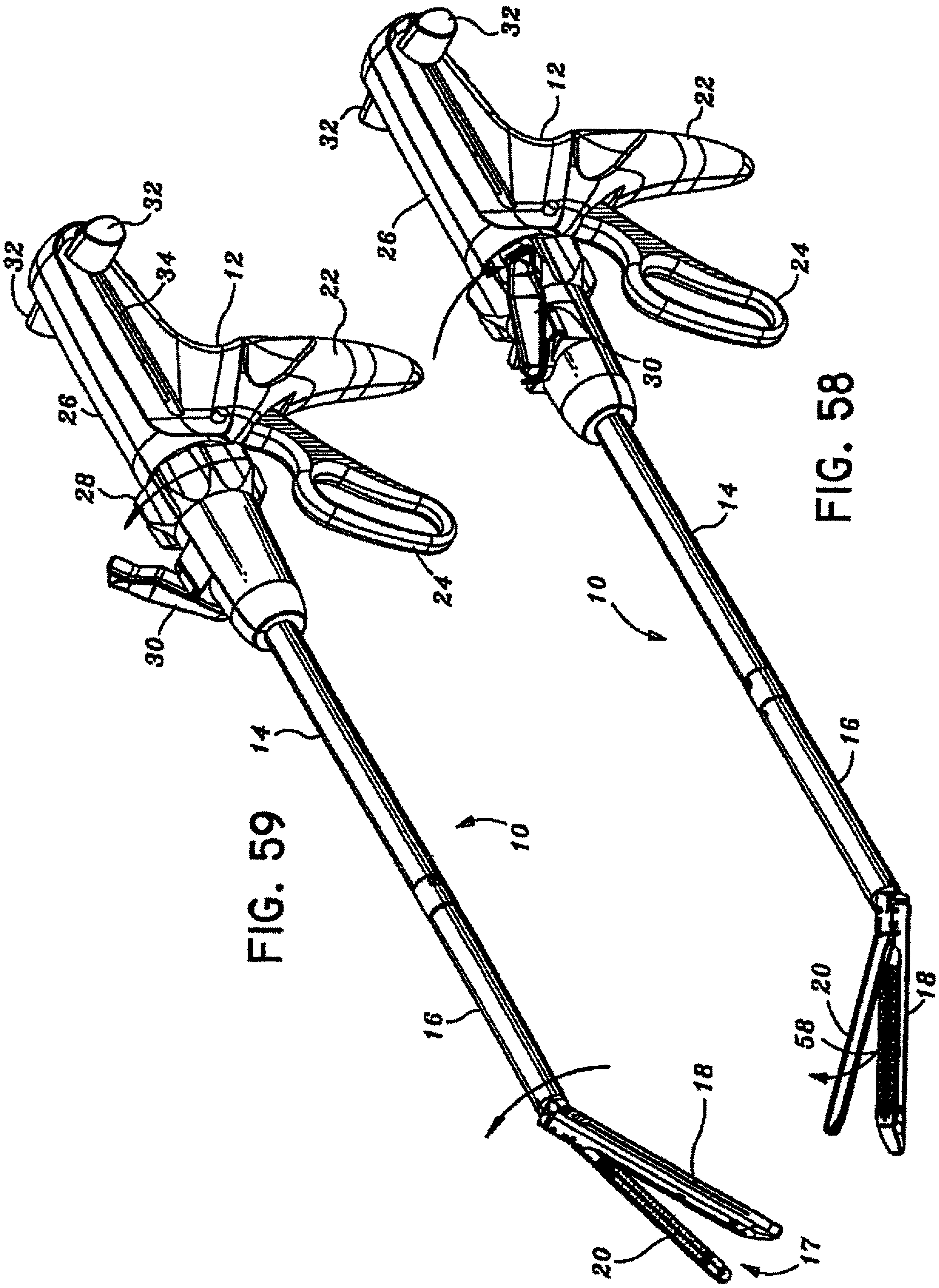

32
32
34
12
22
26
28
24
30
14
10
16
18
20
17
32
32
12
22
26
24
30
14
10
16
20
58
18

FIG. 59

FIG. 58

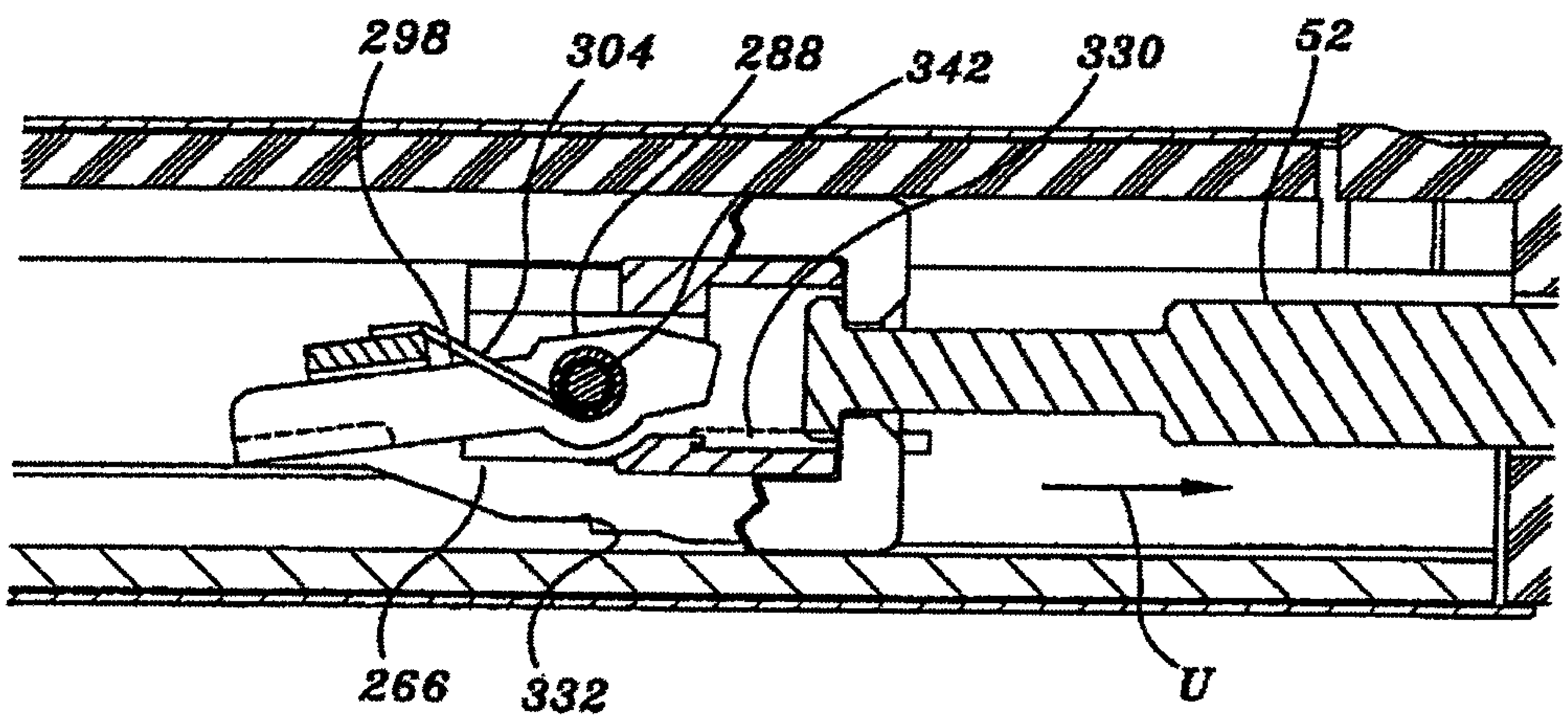


FIG. 62

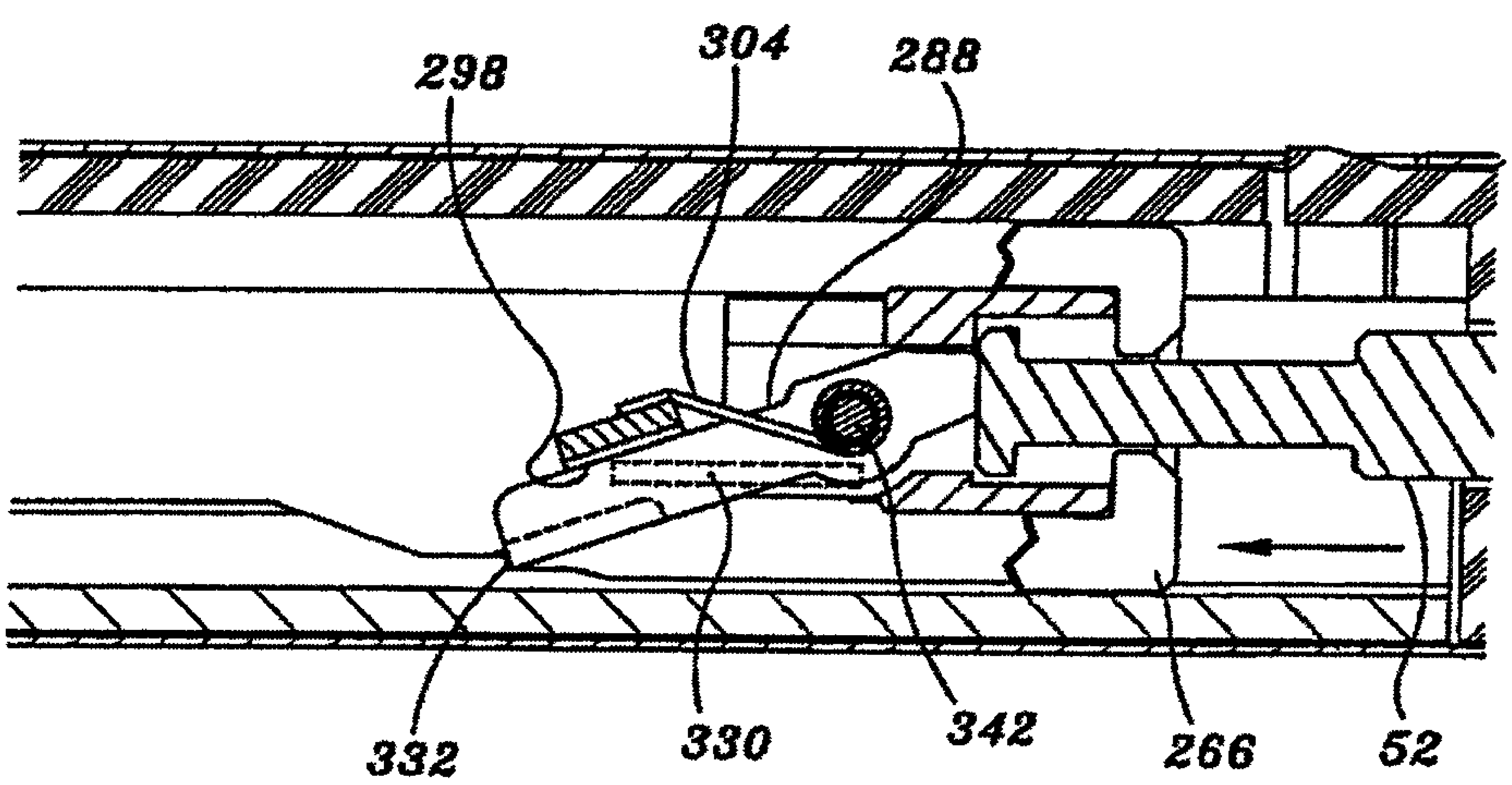


FIG. 63

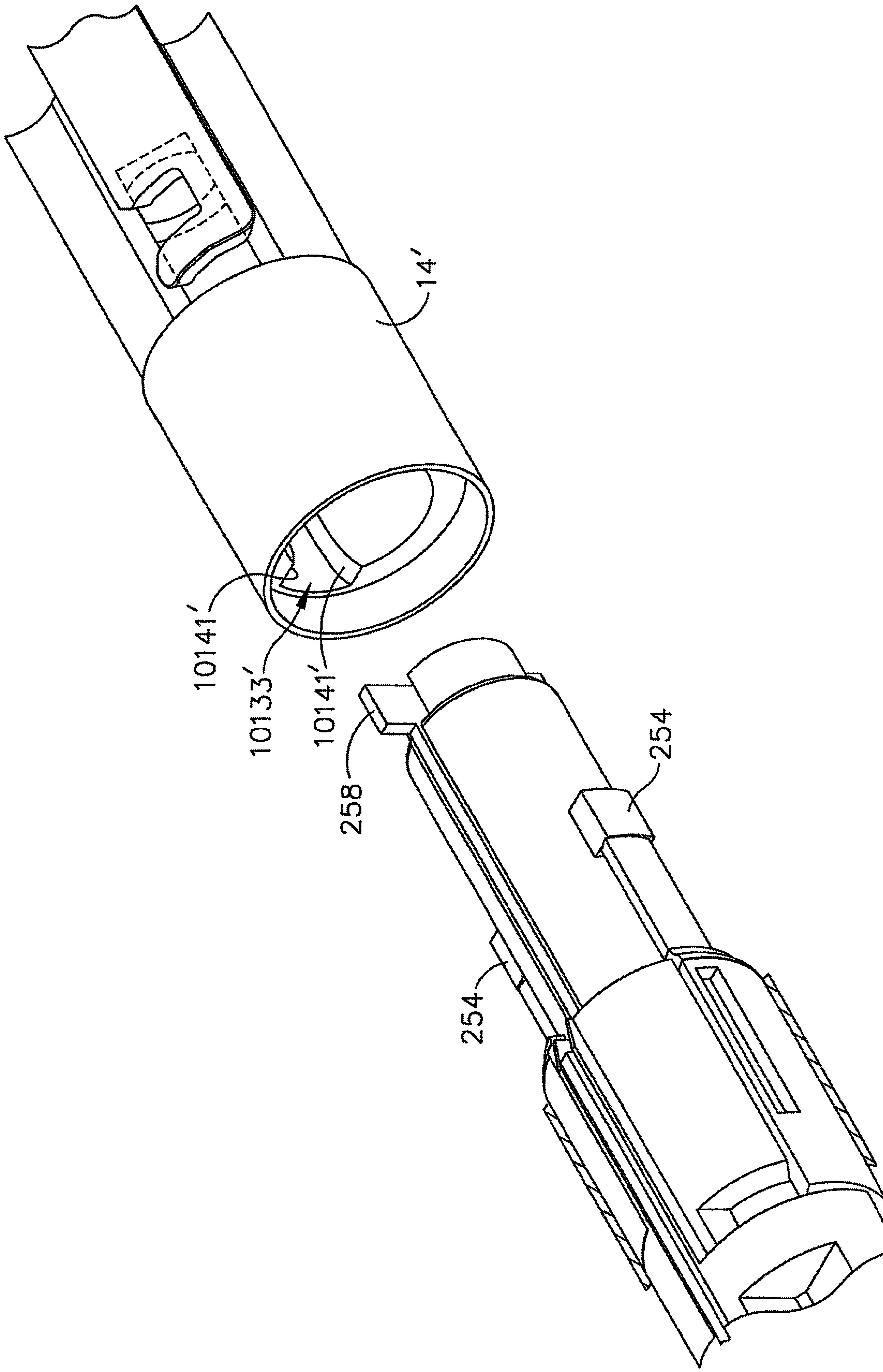


FIG. 64

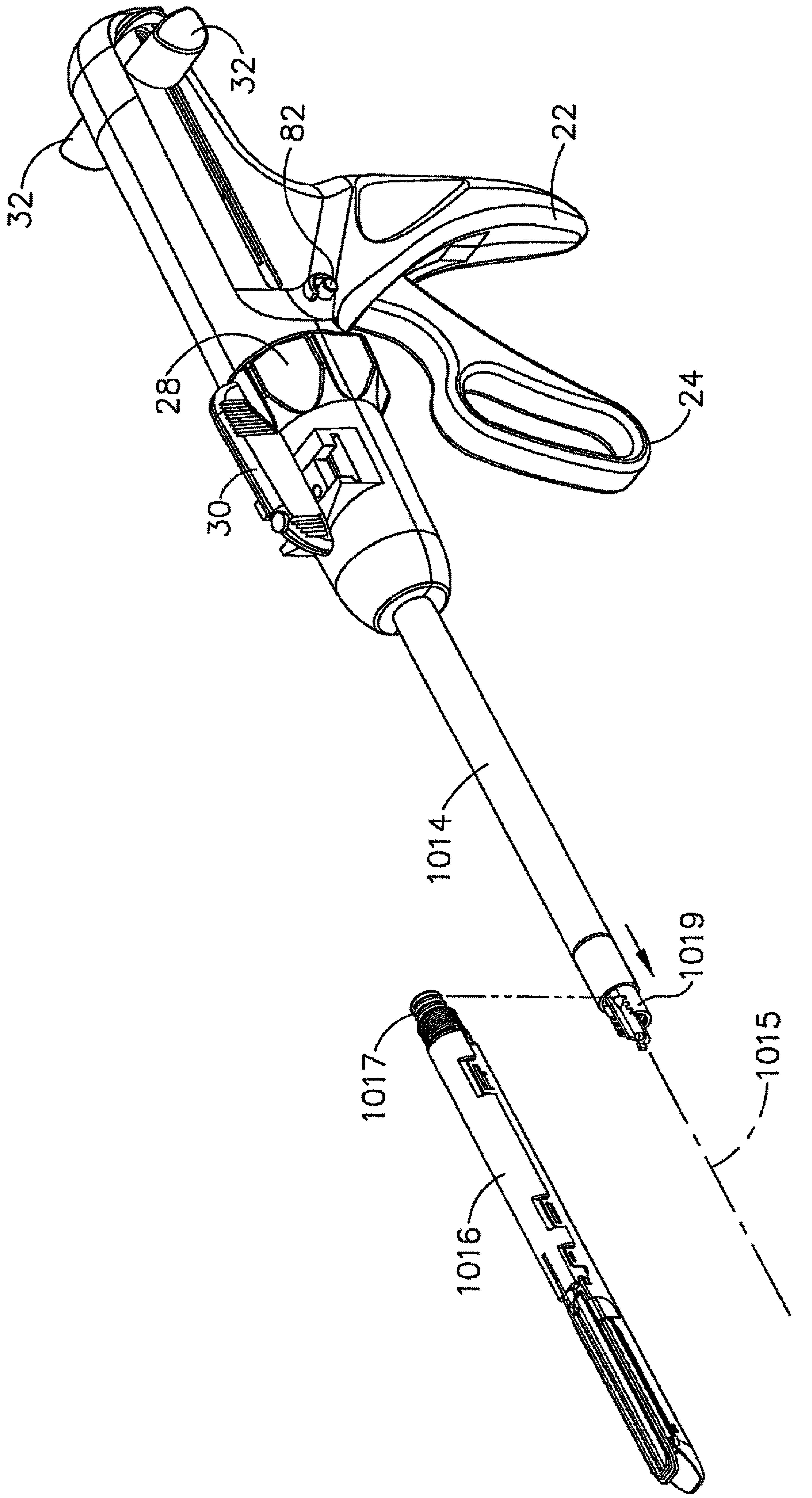


FIG. 65

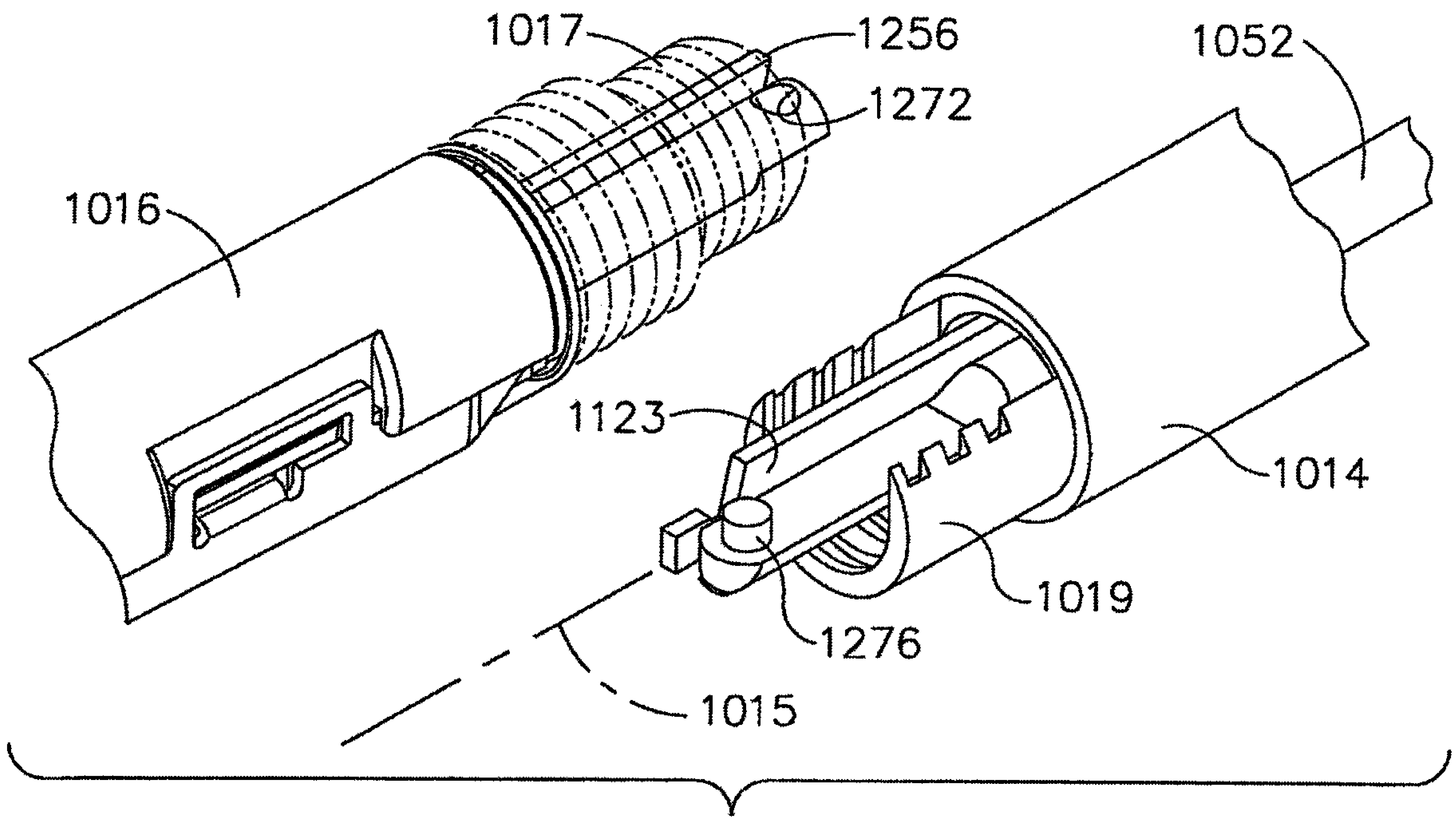

1017
1256
1052
1272
1016
1123
1014
1019
1276
1015

FIG. 66

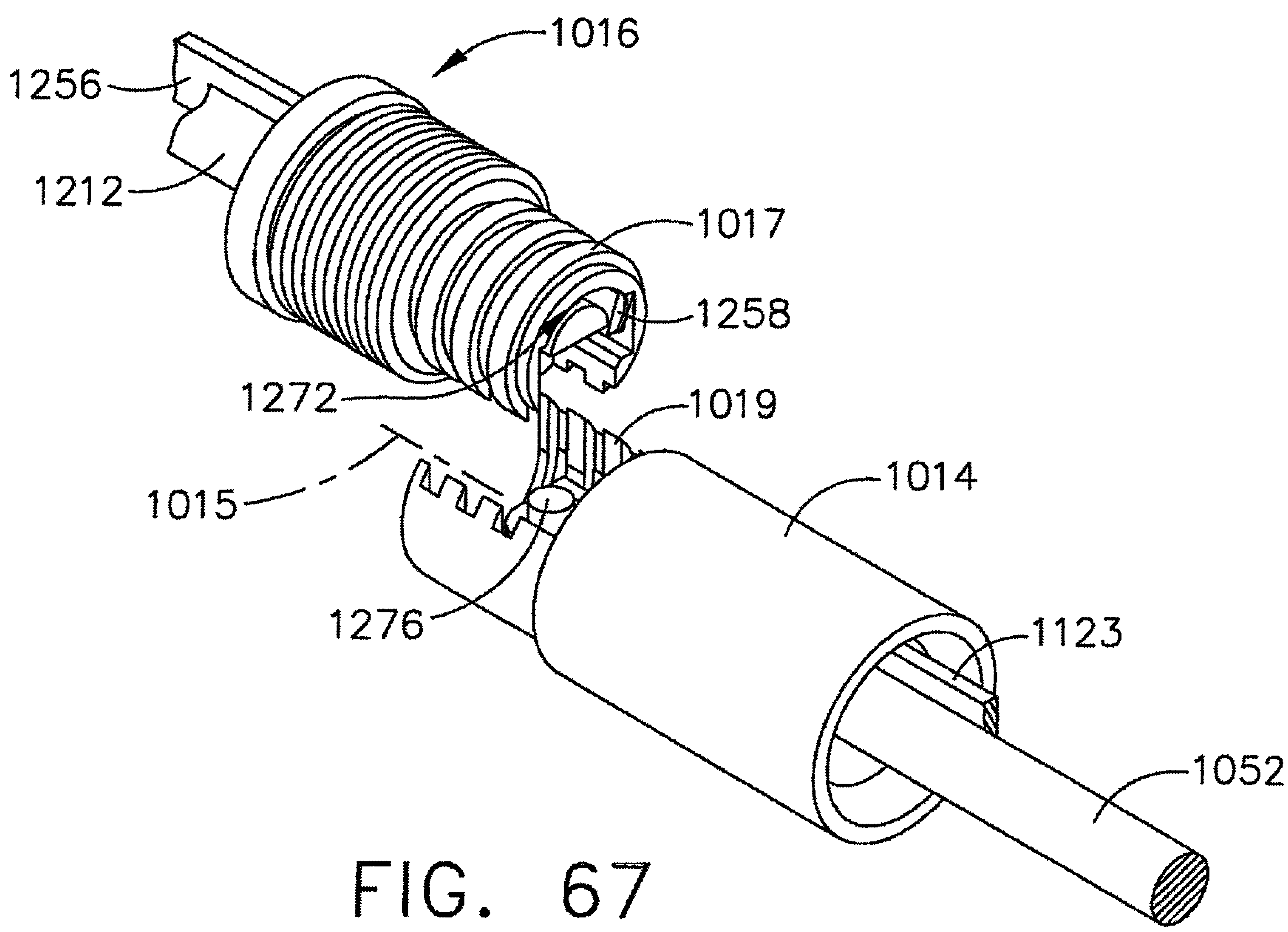

1016
1256
1212
1017
1258
1272
1019
1015
1014
1276
1123
1052

FIG. 67

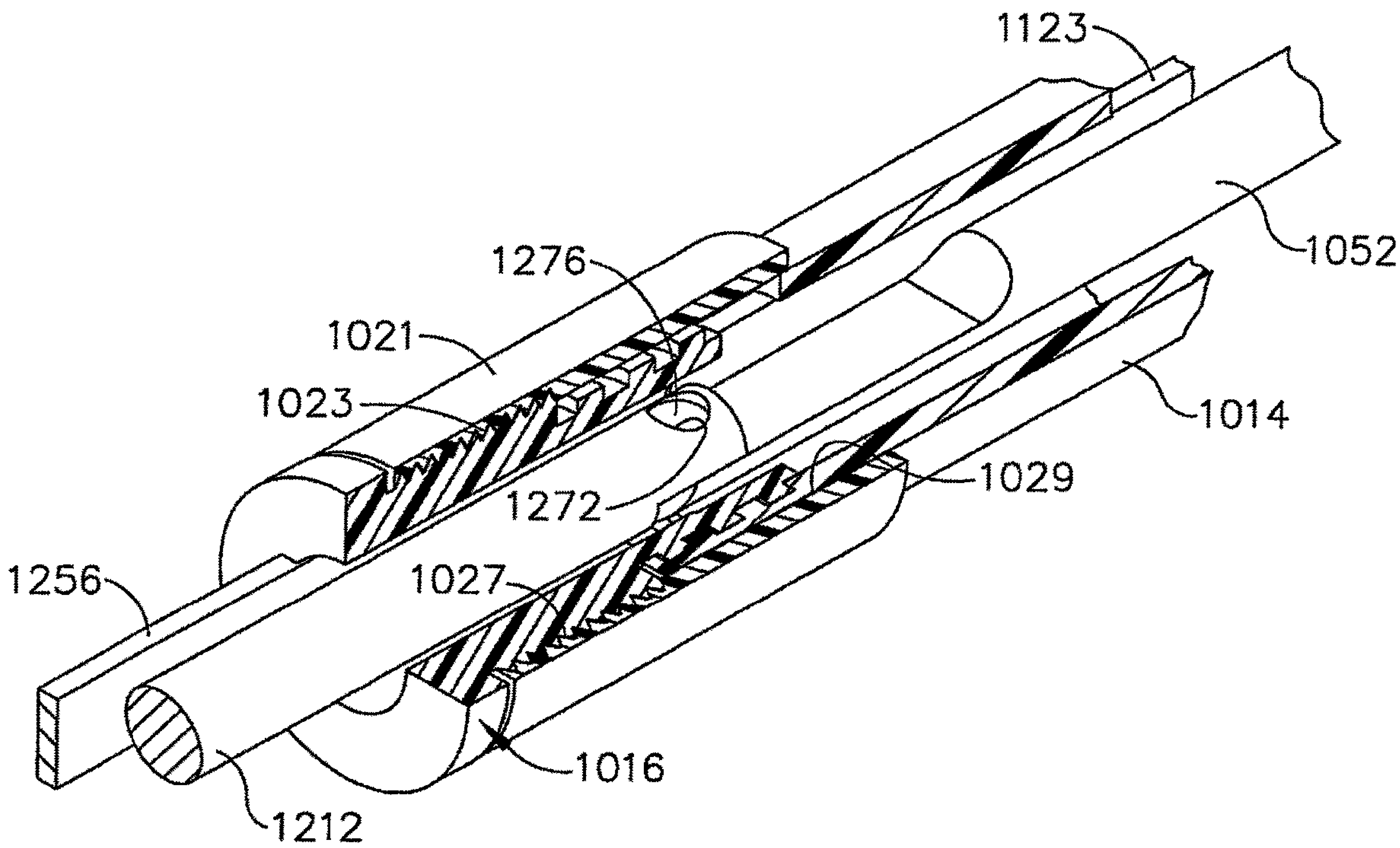

1123
1052
1276
1021
1023
1014
1029
1272
1256
1027
1016
1212

FIG. 68

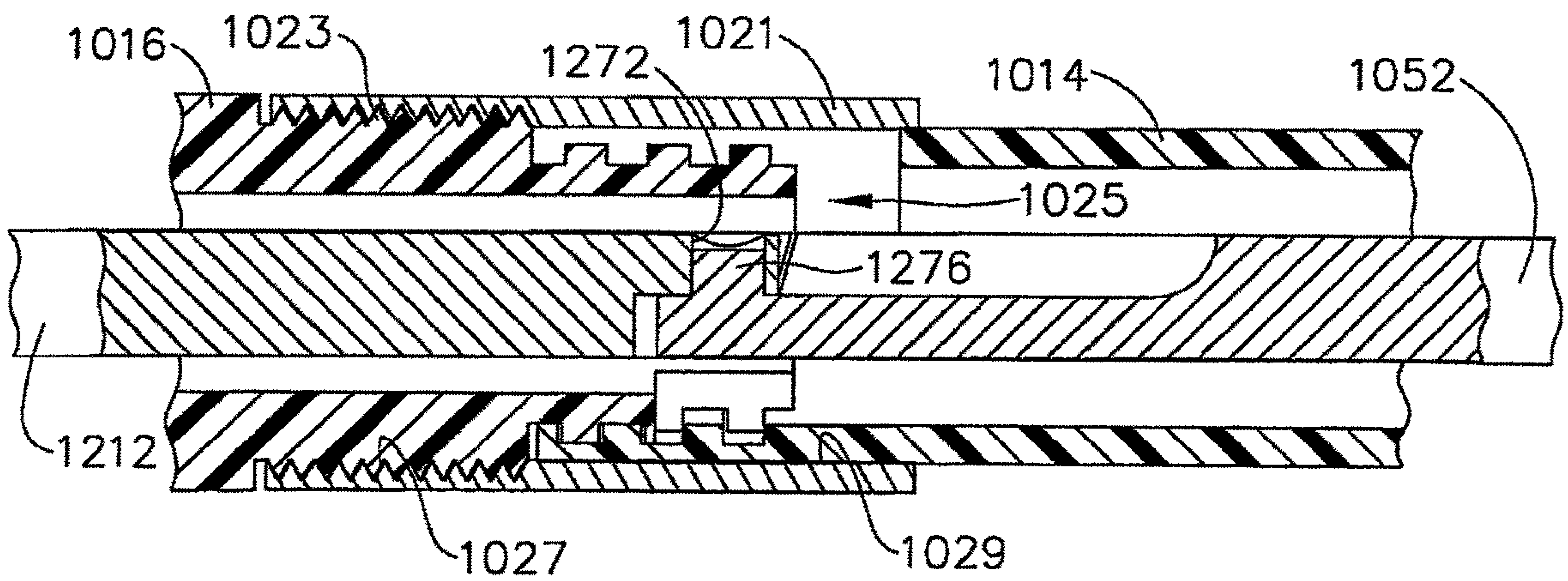
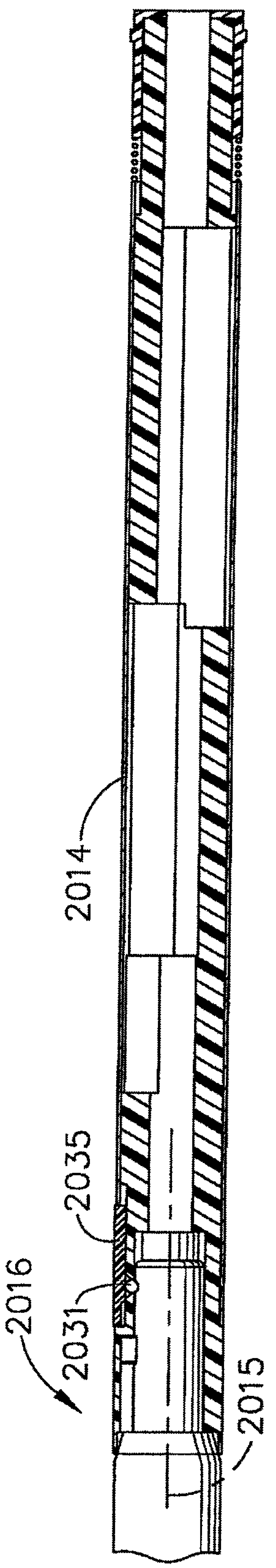
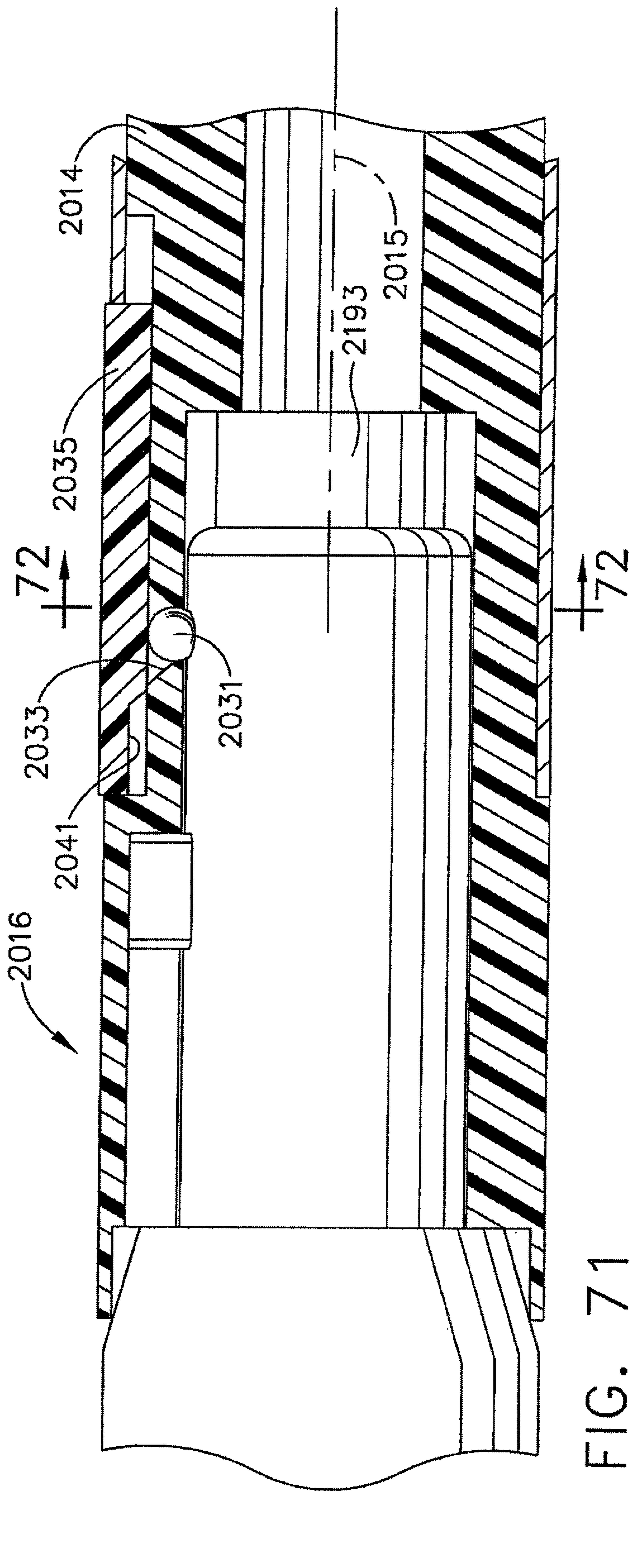

1016
1023
1272
1021
1014
1052
1025
1276
1212
1027
1029

FIG. 69



2014
2035
2016
2031
2015

FIG. 70



2014
2015
2193
2035
72
72
2033
2031
2041
2016

FIG. 71

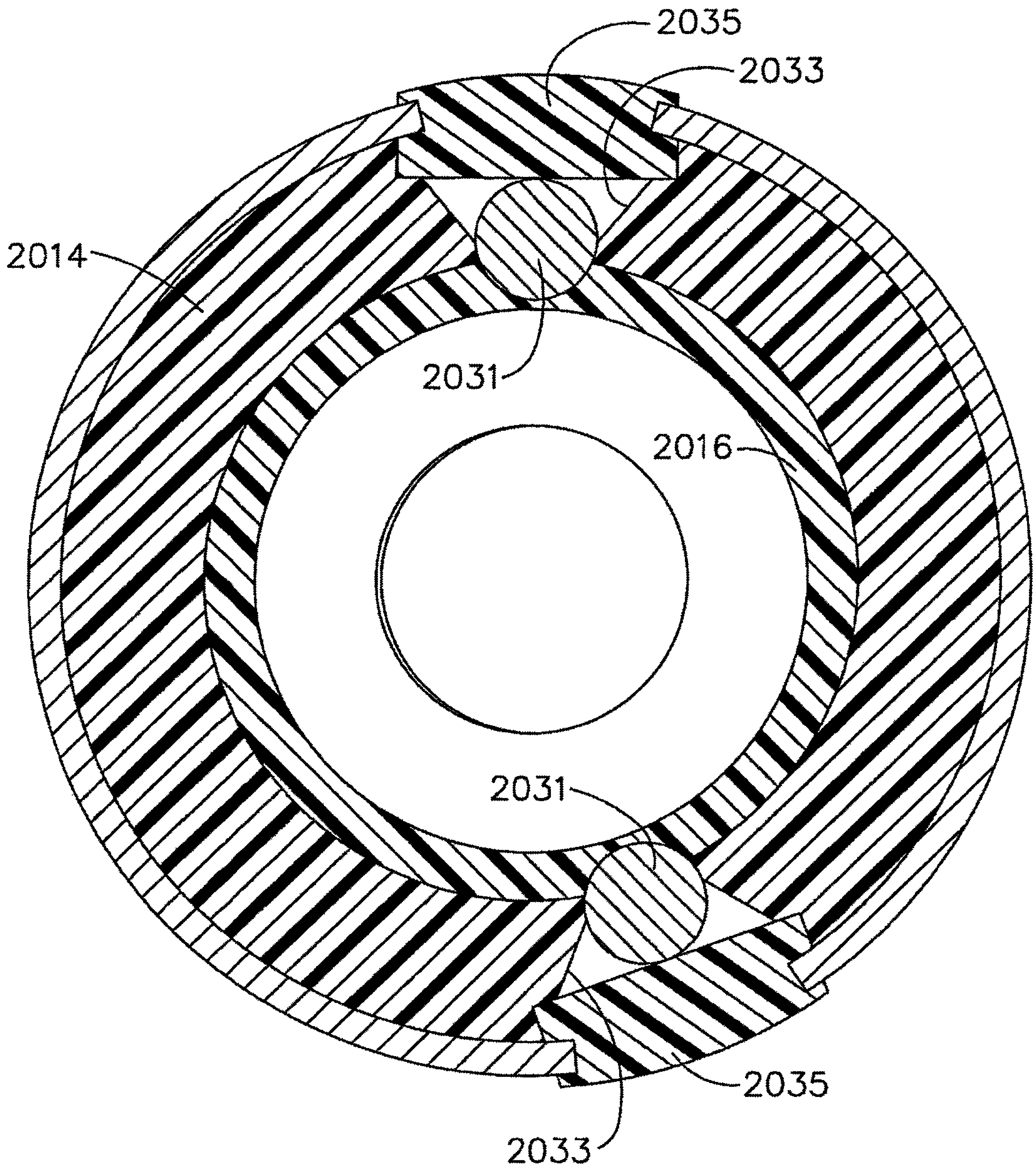


FIG. 72

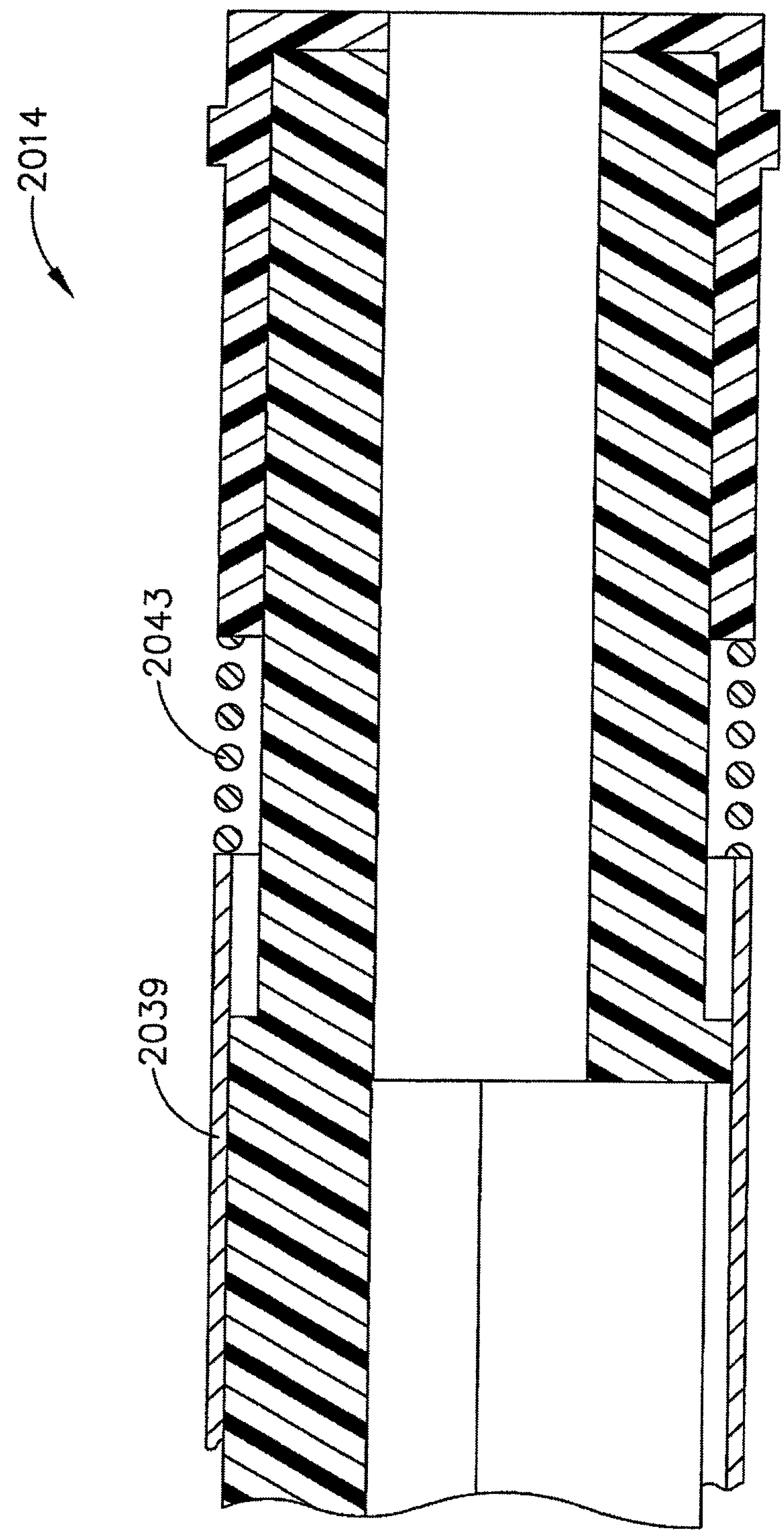


FIG. 73

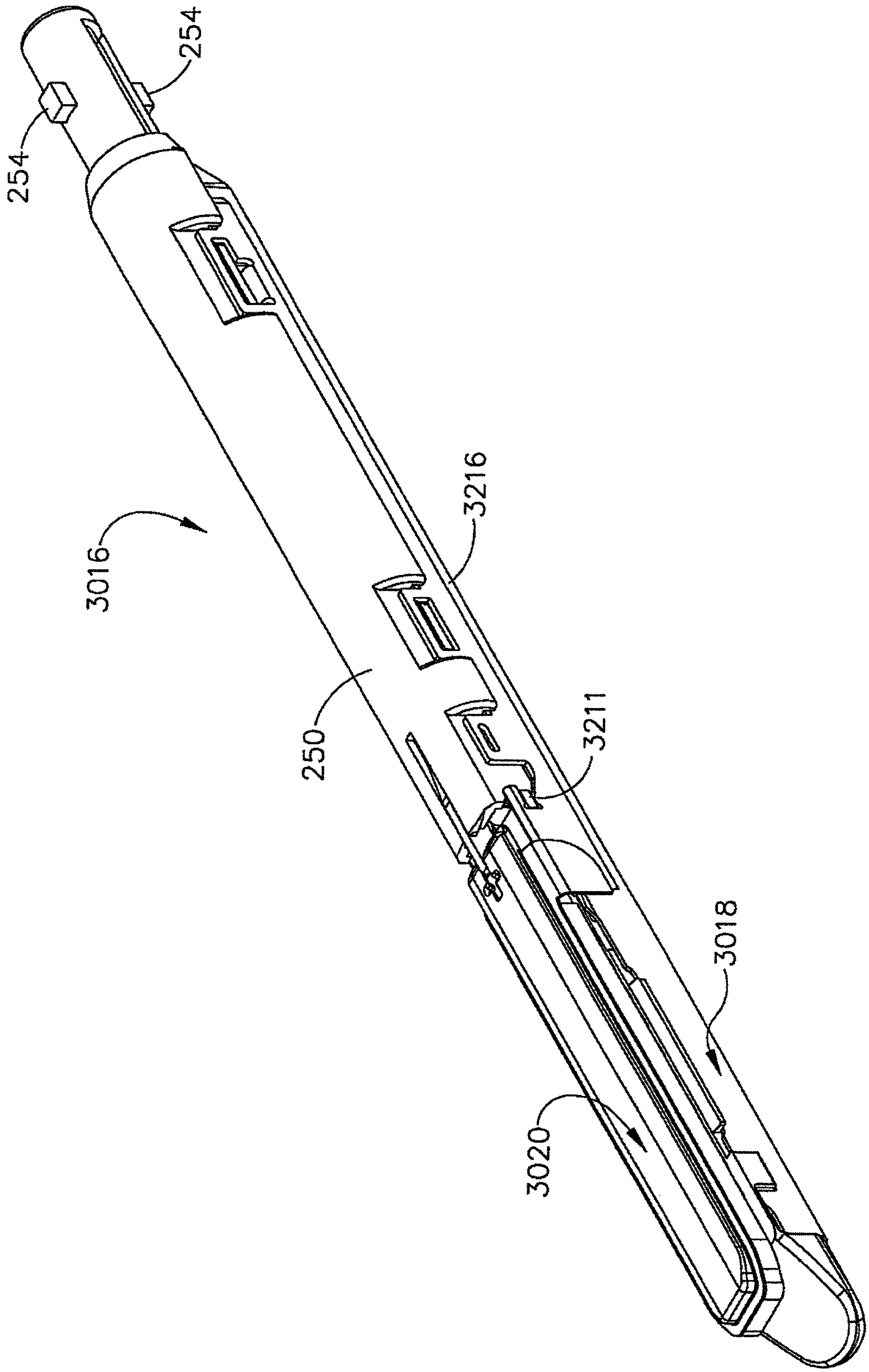


FIG. 74

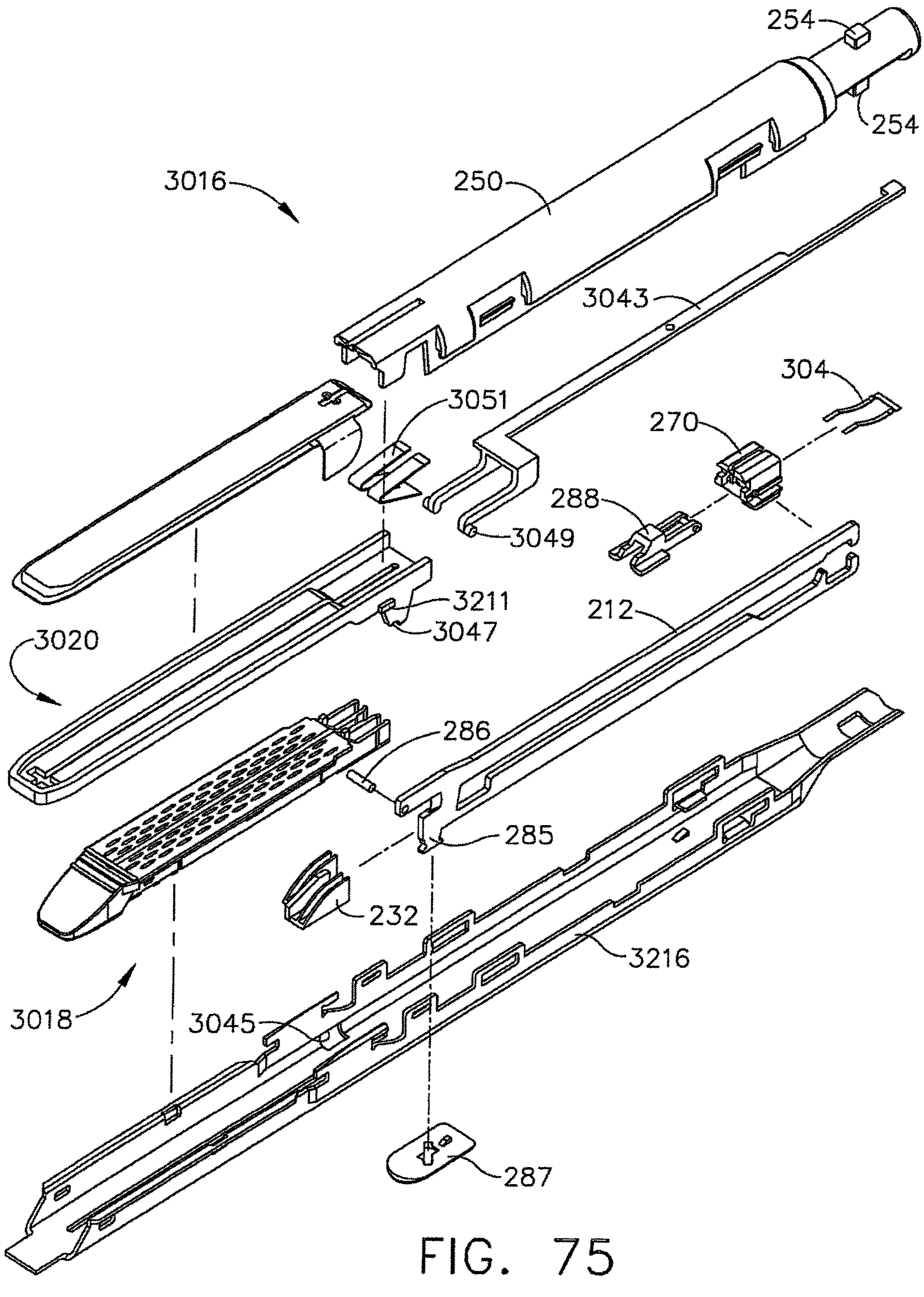

254
254
3016
250
3043
304
3051
270
288
3049
3211
212
3020
3047
286
285
232
3216
3018
3045
287

FIG. 75

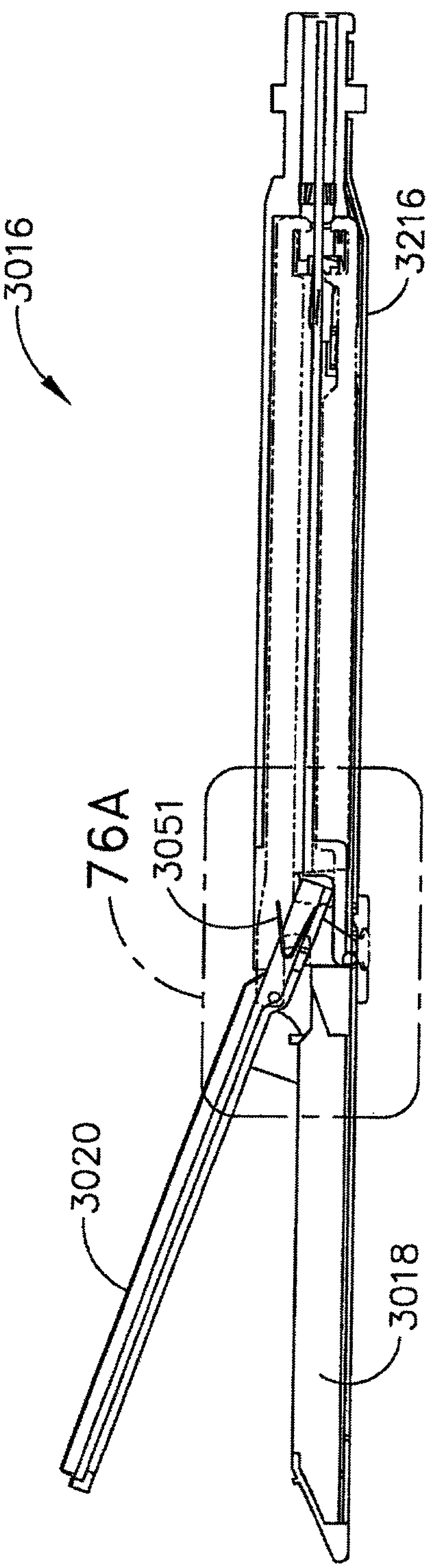


FIG. 76

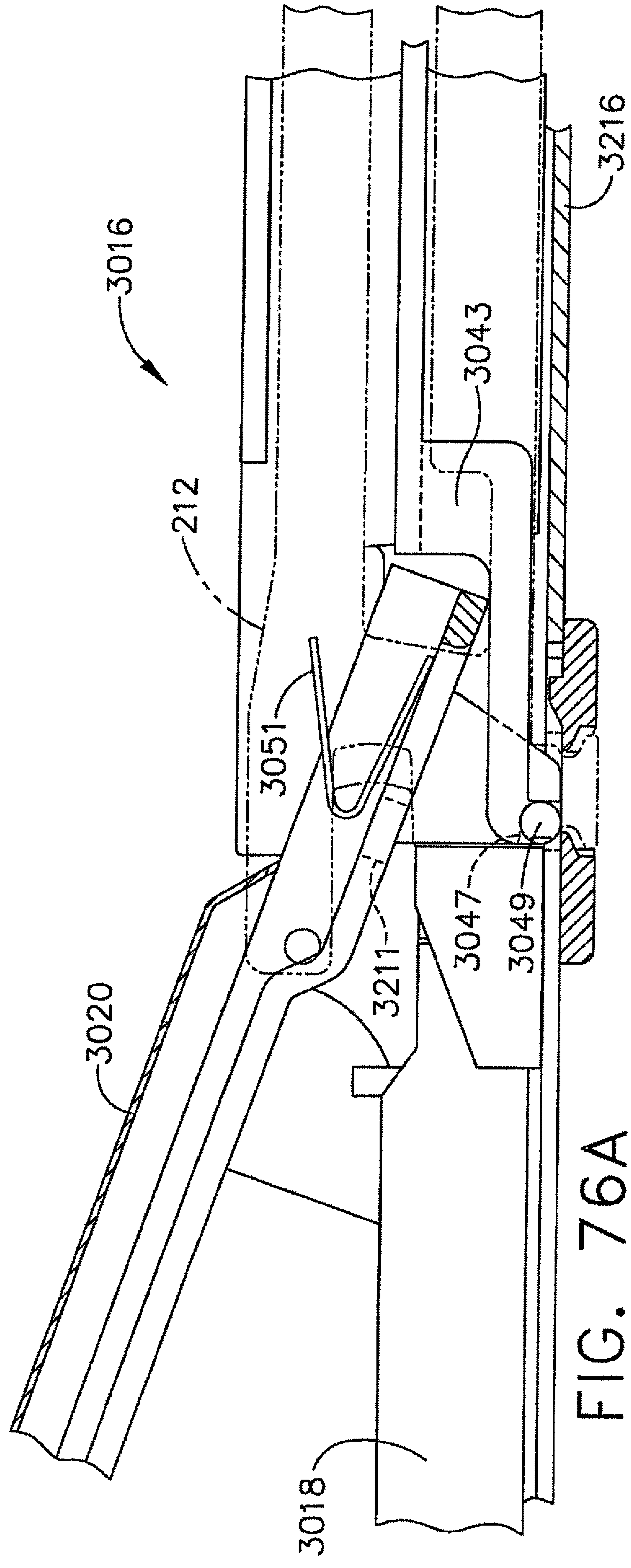


FIG. 76A

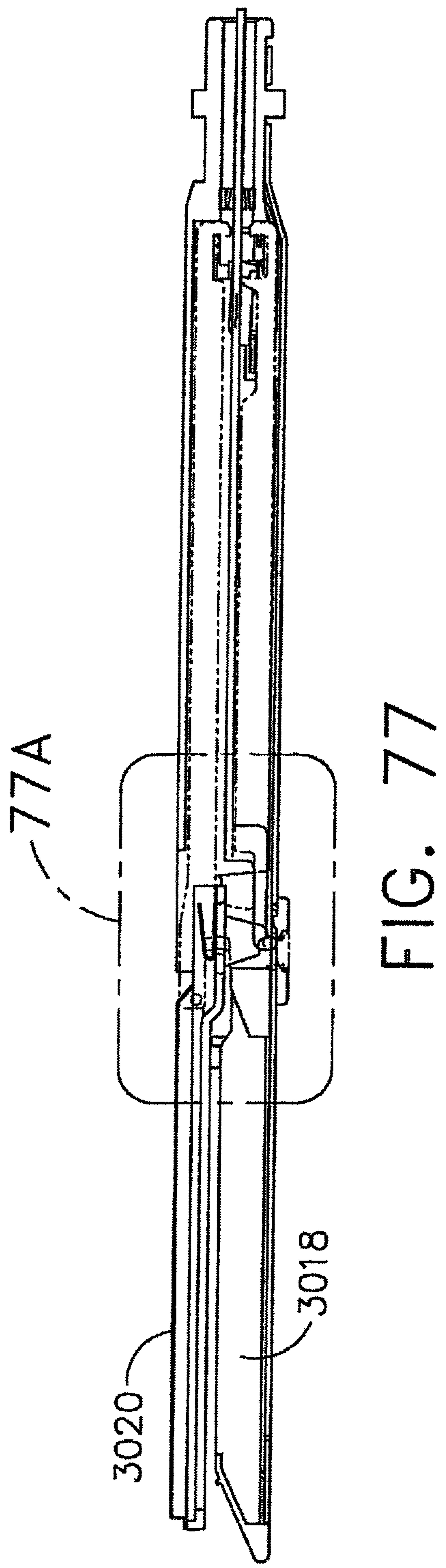


FIG. 77

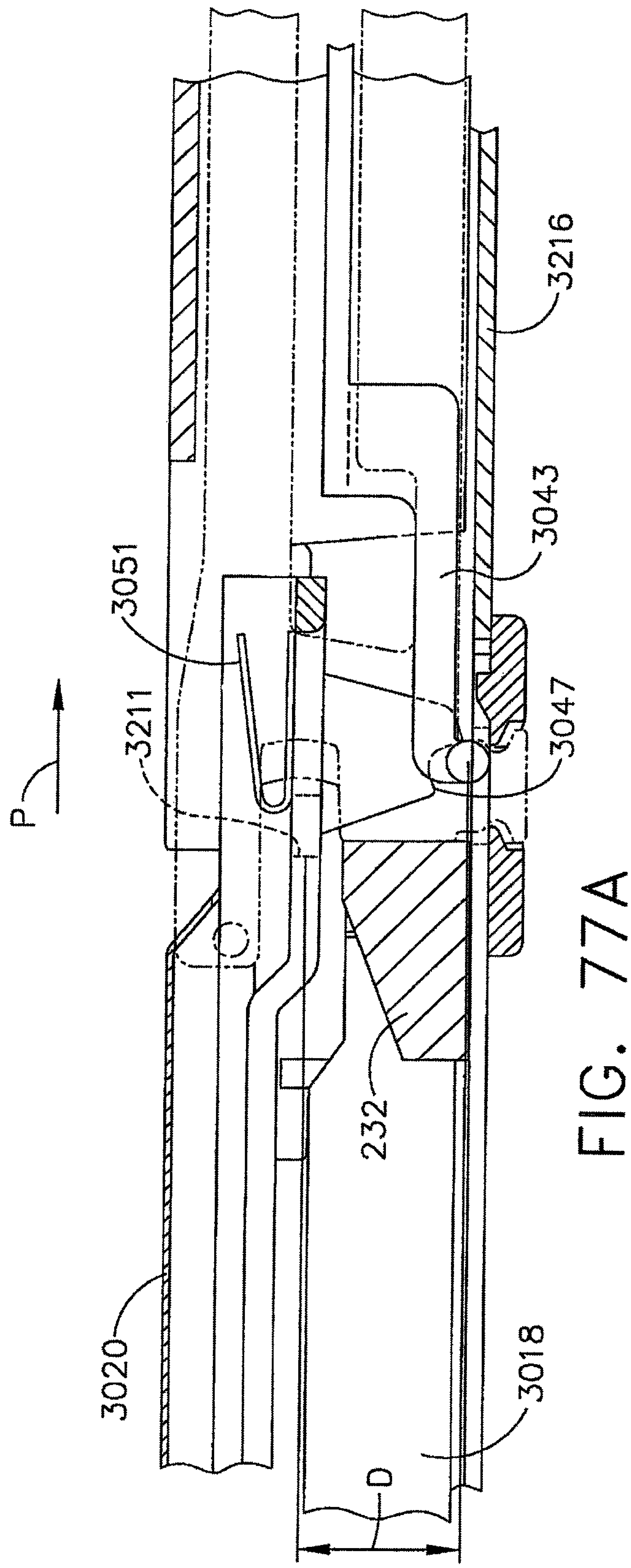


FIG. 77A

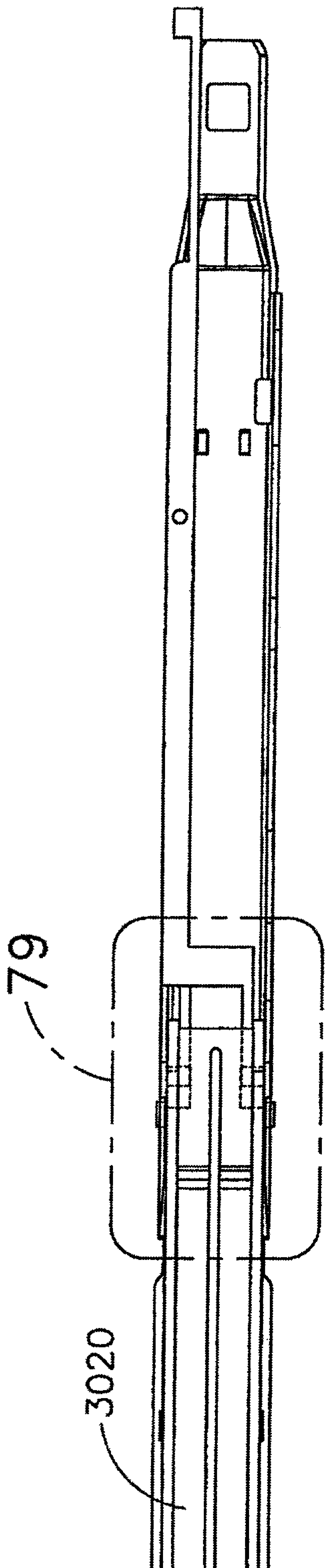


FIG. 78

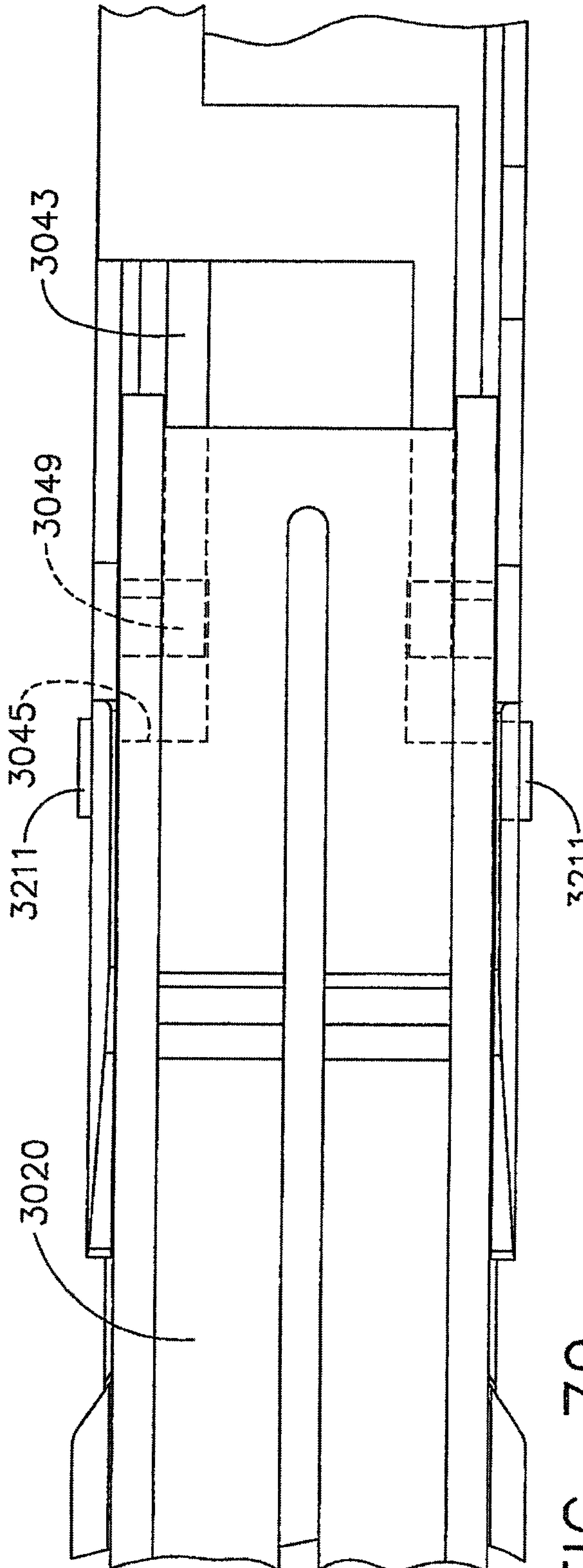


FIG. 79

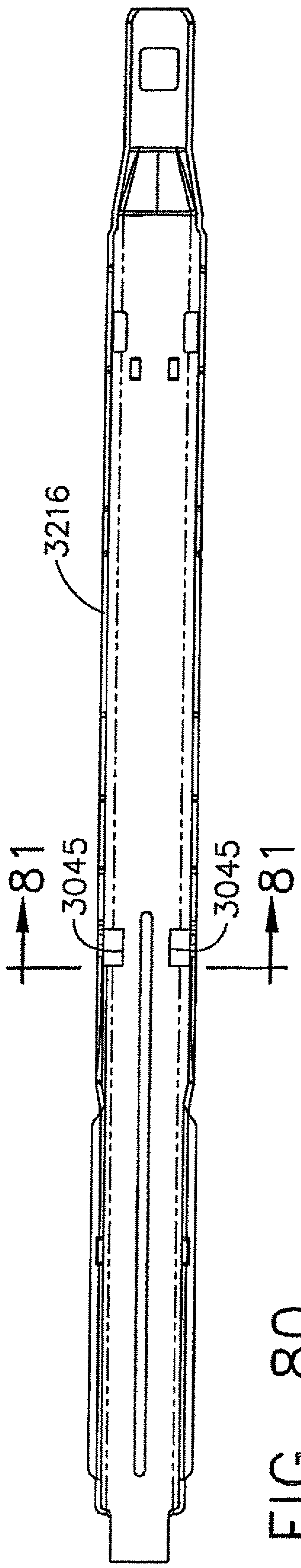


FIG. 80

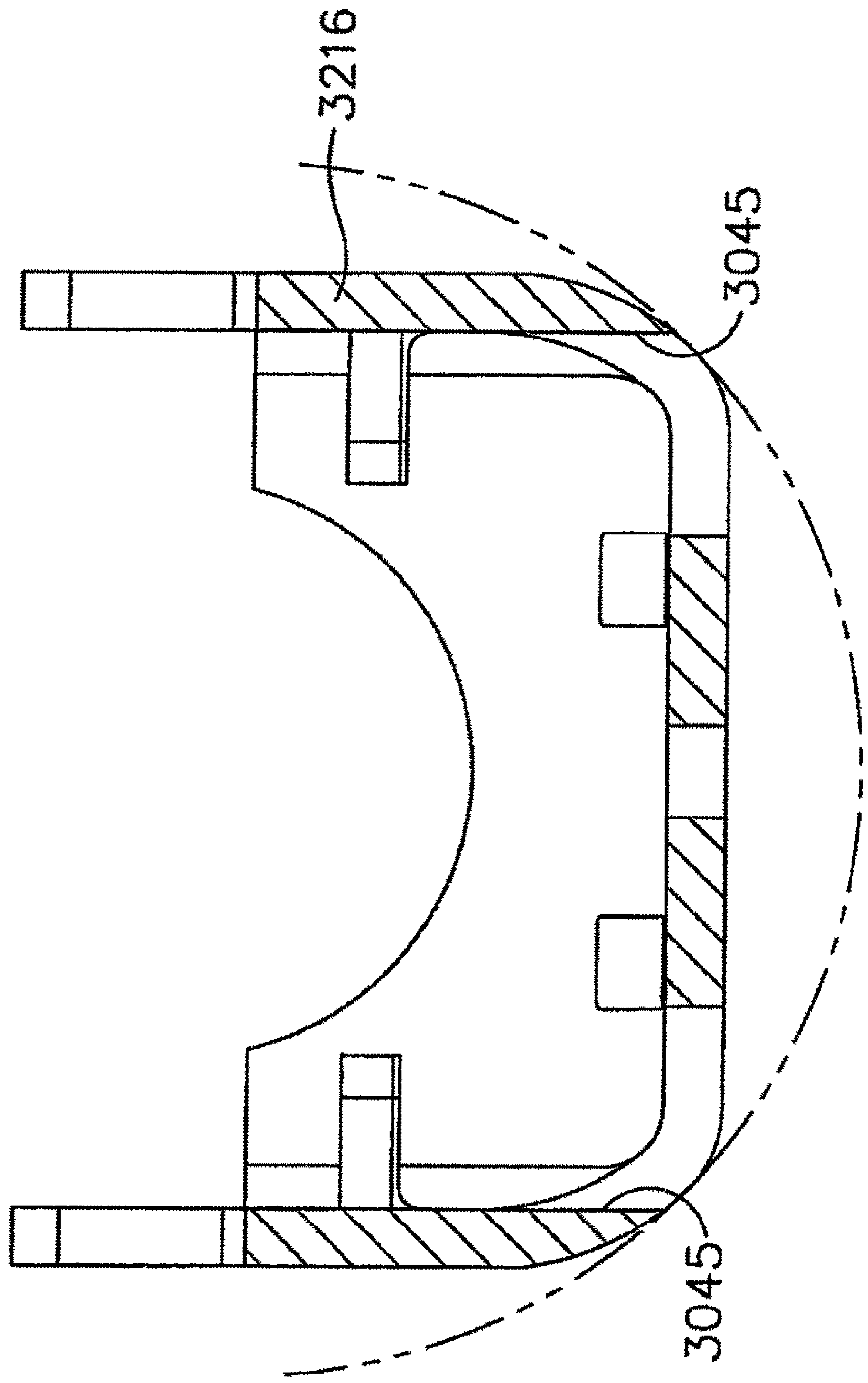


FIG. 81

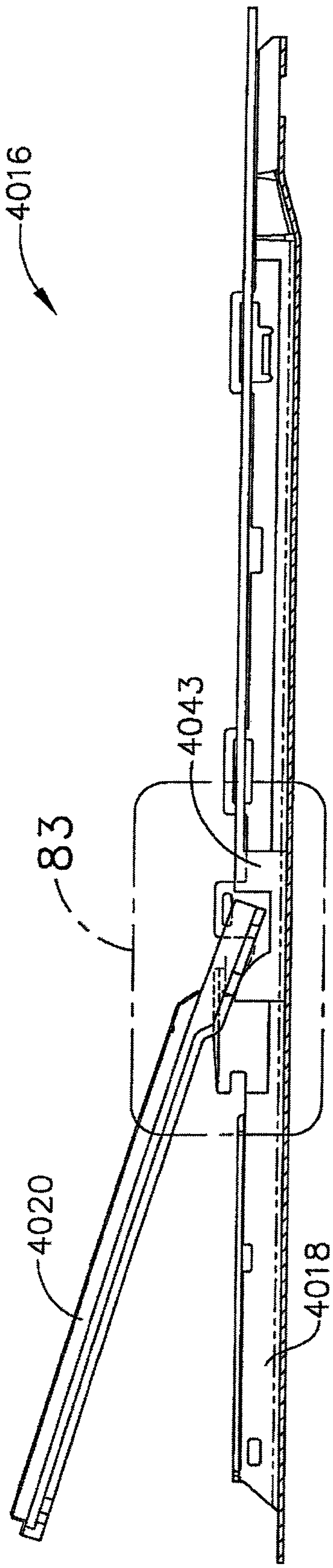

4016
83
4043
4020
4018

FIG. 82

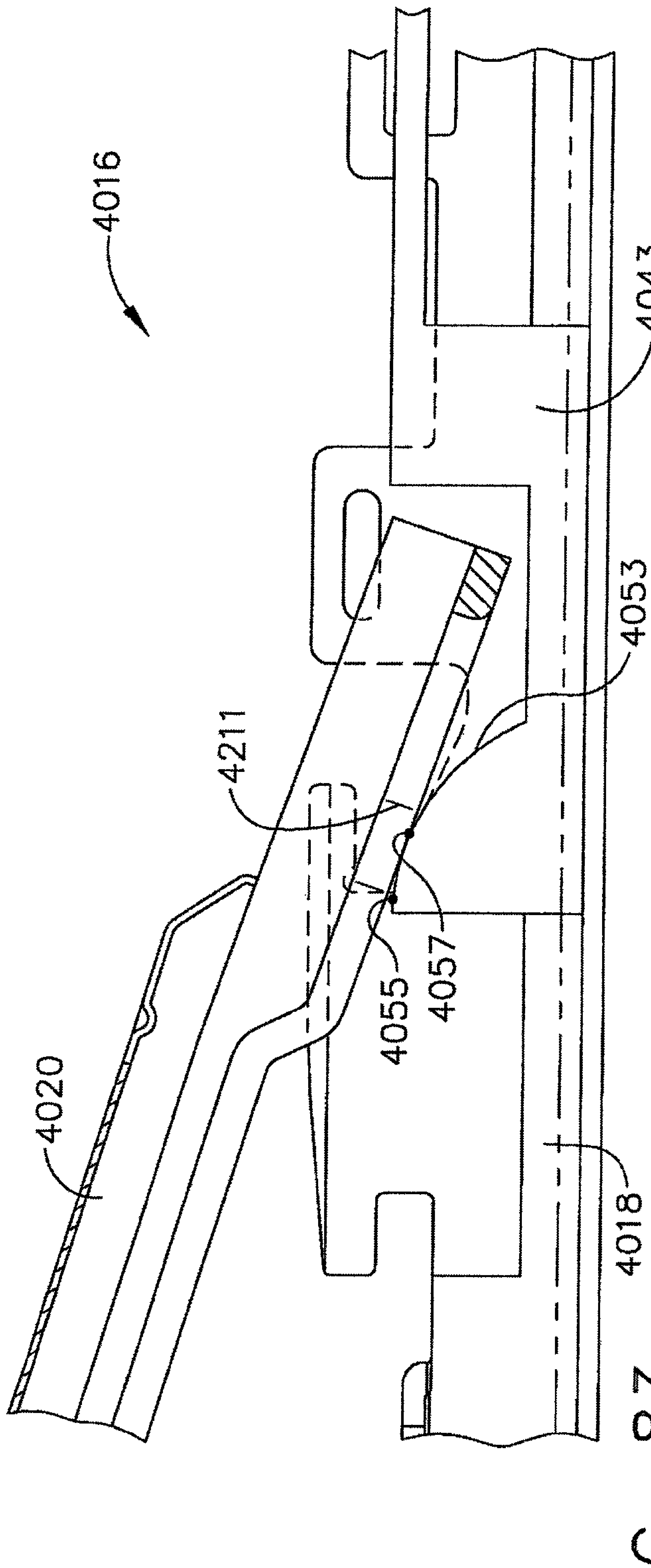

4016
4043
4053
4211
4055
4057
4020
4018

FIG. 83

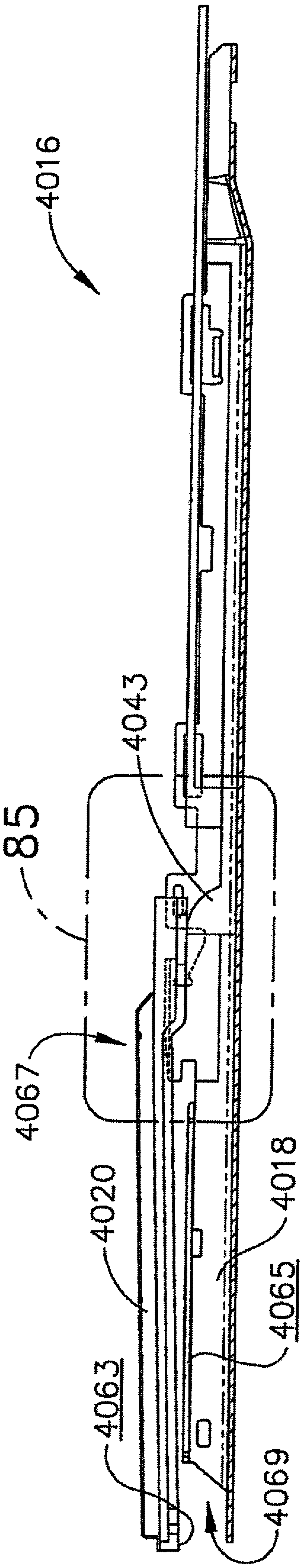

4016
85
4043
4067
4020
4018
4065
4063
4069

FIG. 84

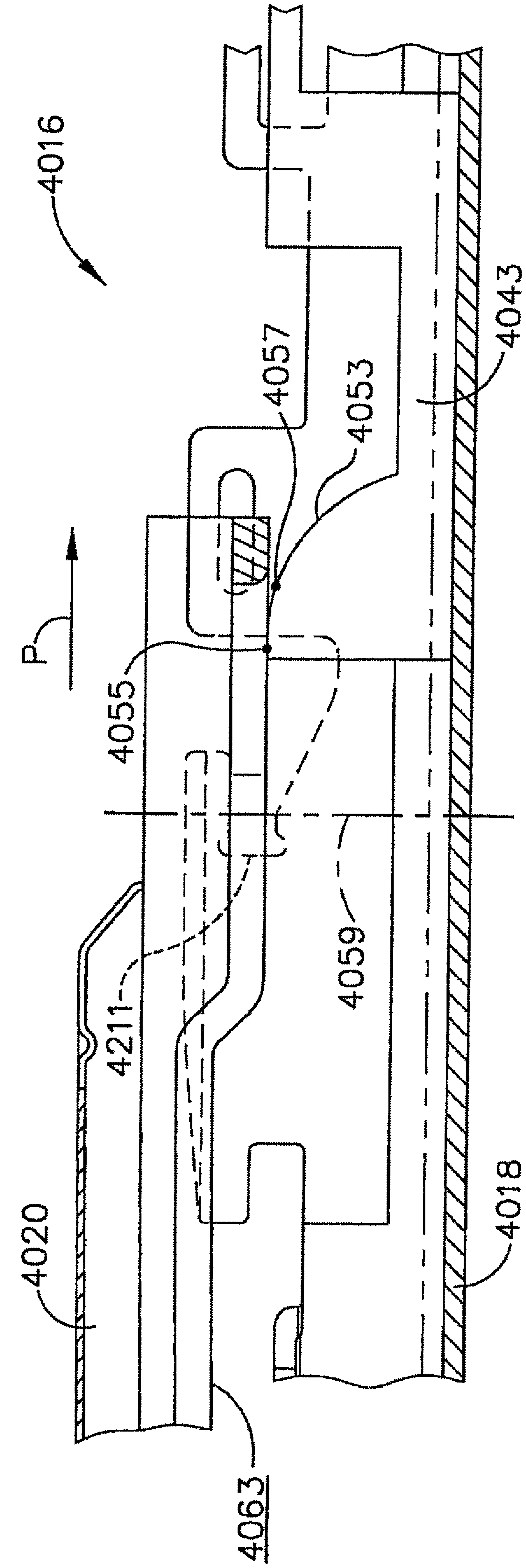
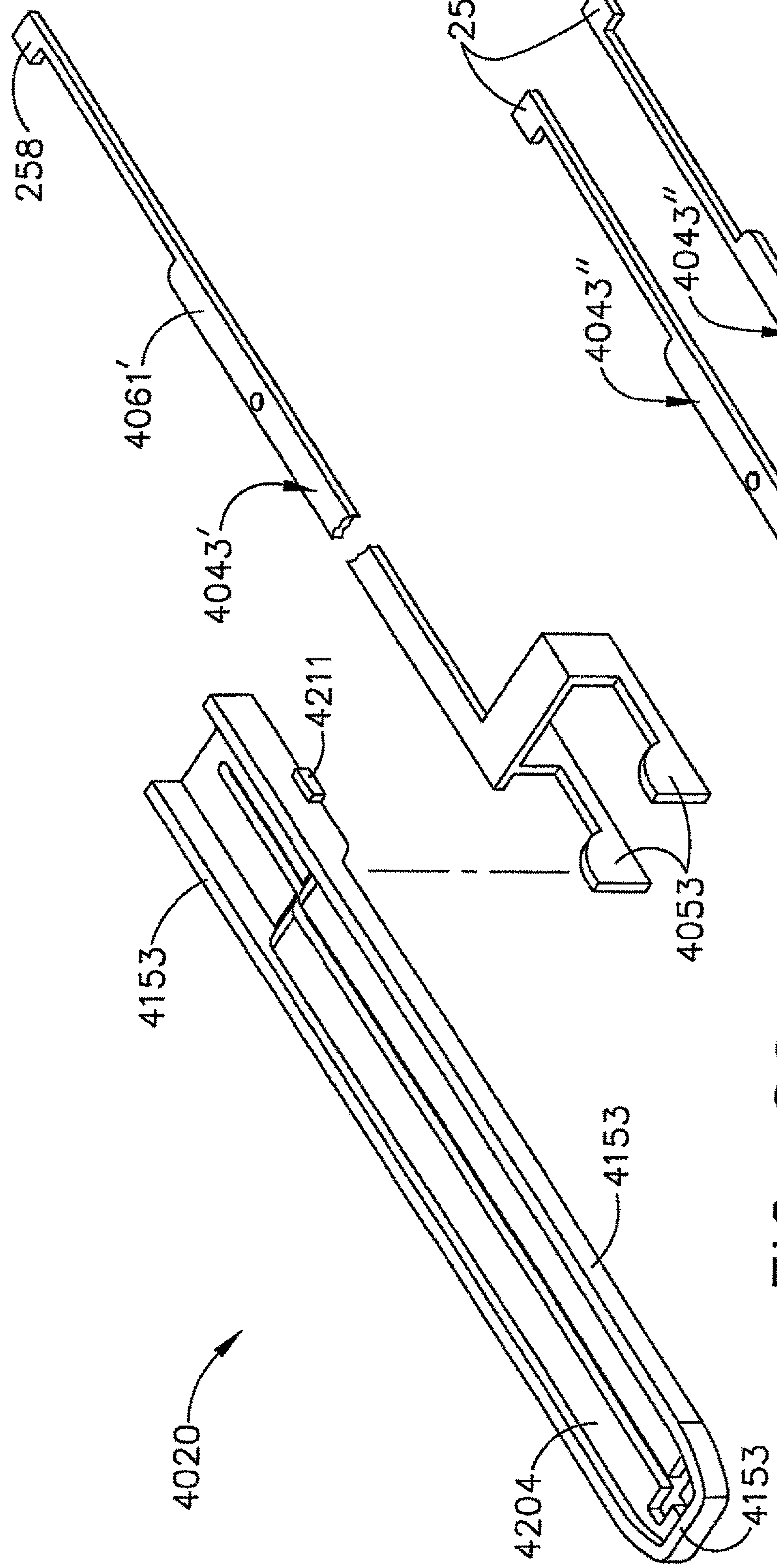
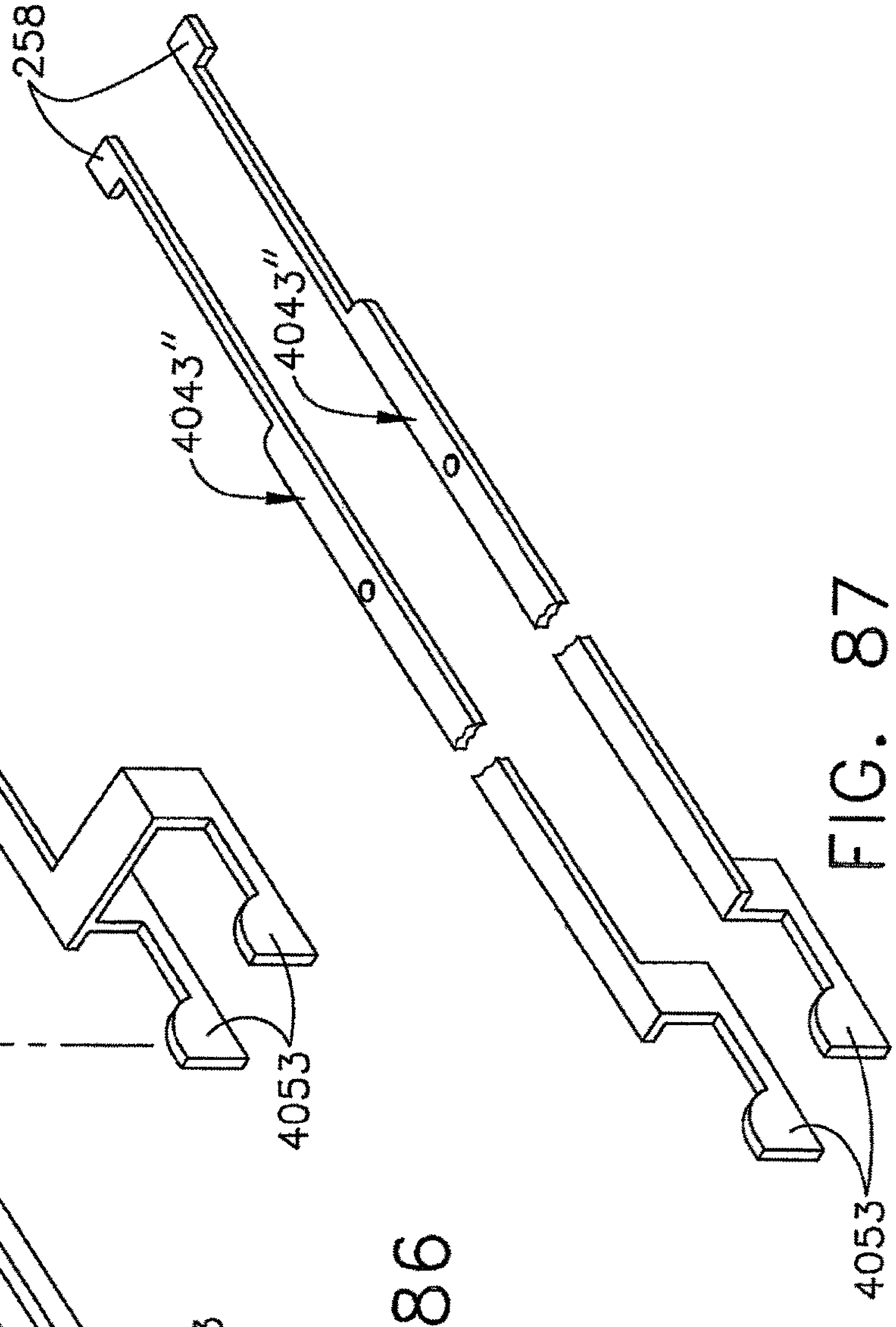

4016
P
4057
4053
4043
4055
4211
4059
4020
4063
4018

FIG. 85



258
4061'
4043'
4211
4053
4153
4153
4020
4204
4153

FIG. 86



258
4043''
4043''
4053

FIG. 87

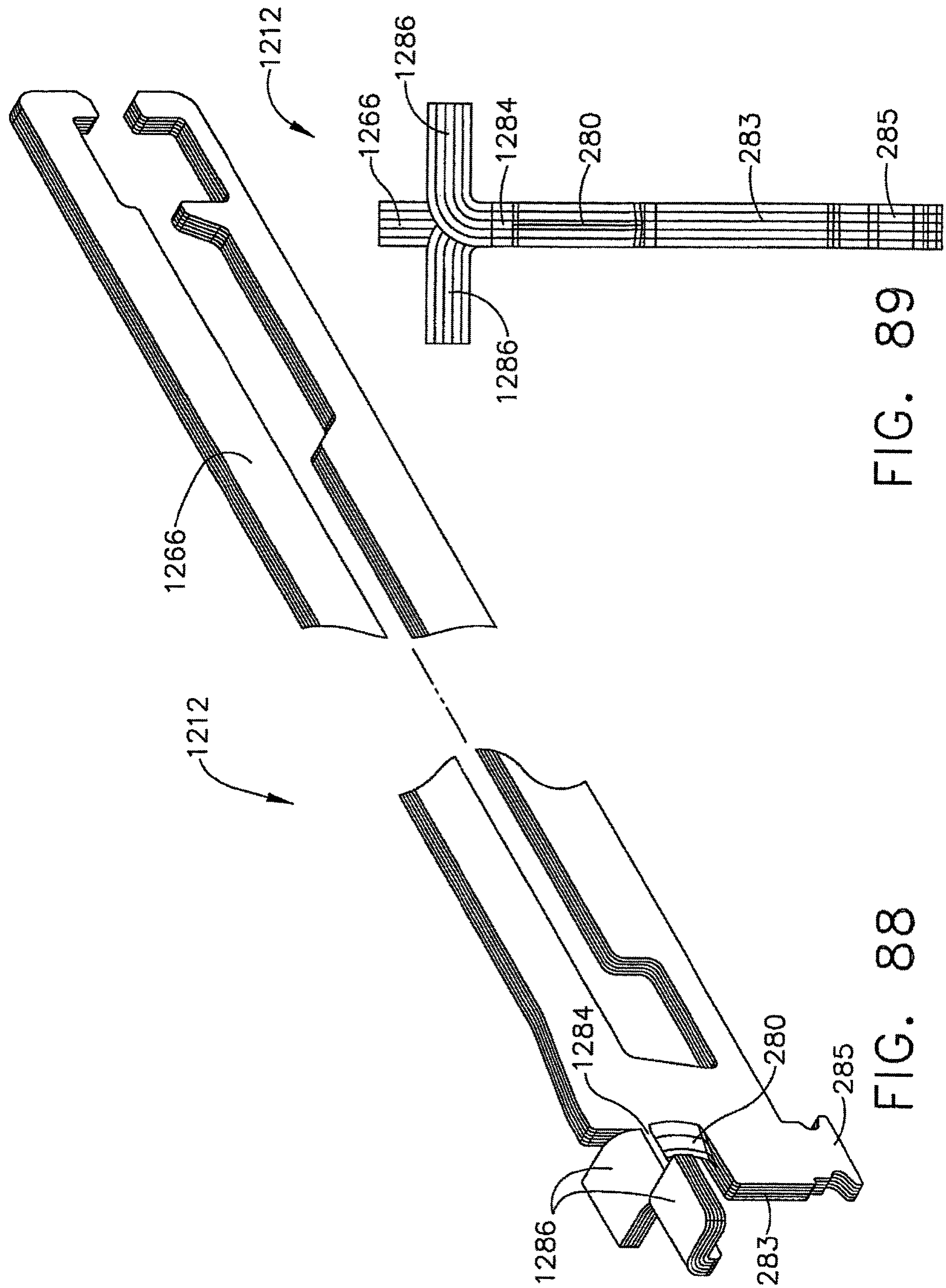

1212
1286
1266
1284
280
283
285
1286
1266
1212
1284
280
285
1286
283

FIG. 89

FIG. 88

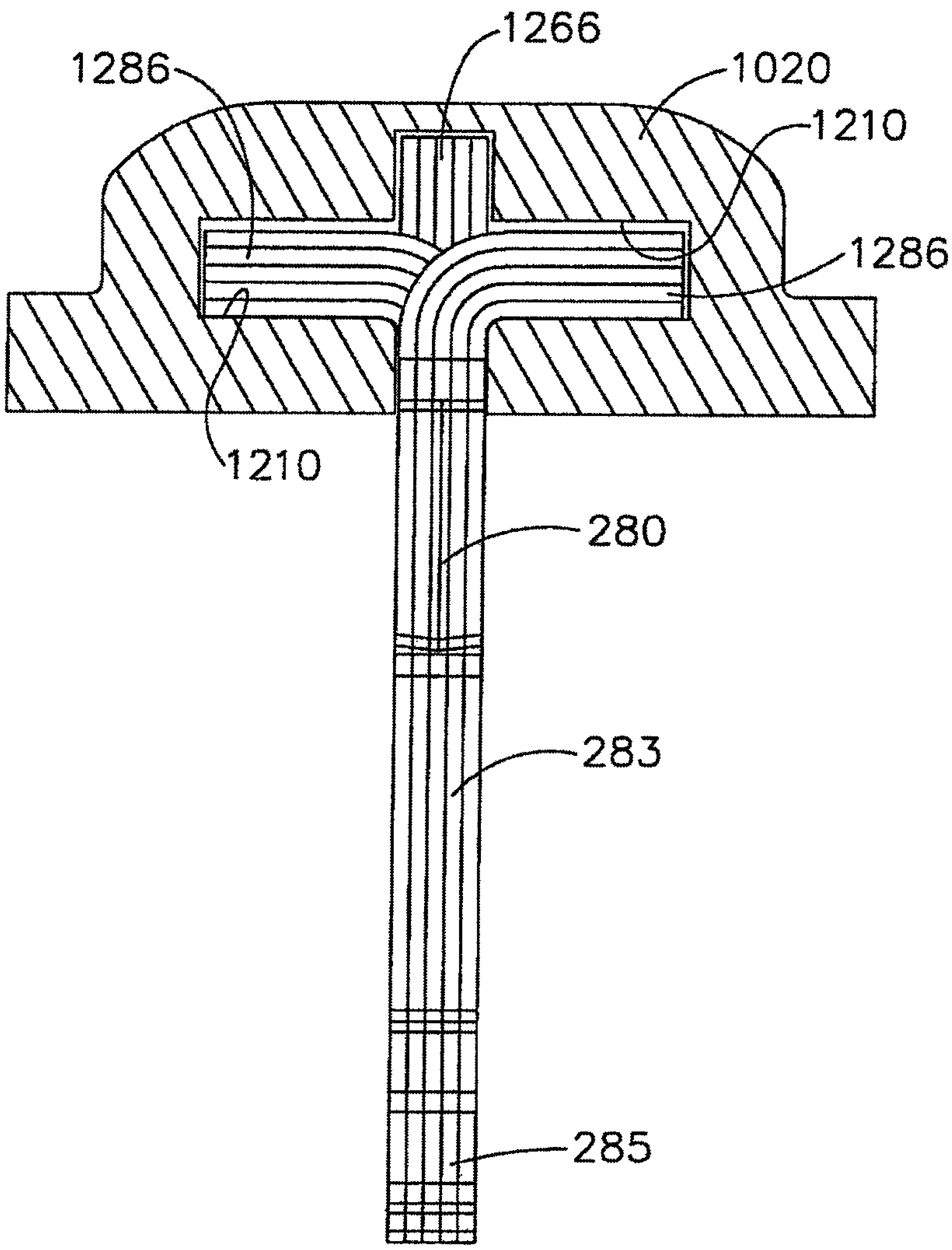


FIG. 90

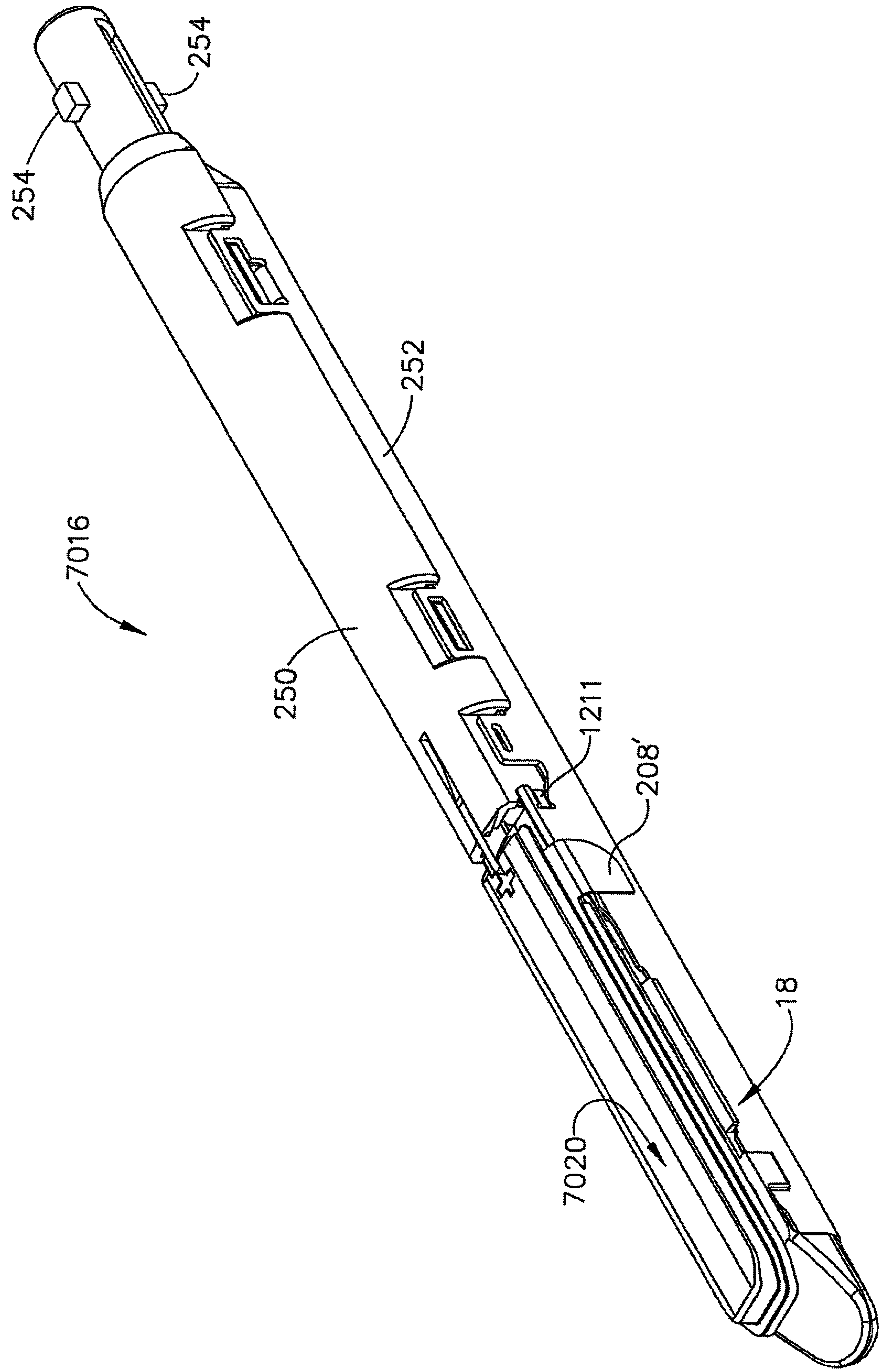


FIG. 91

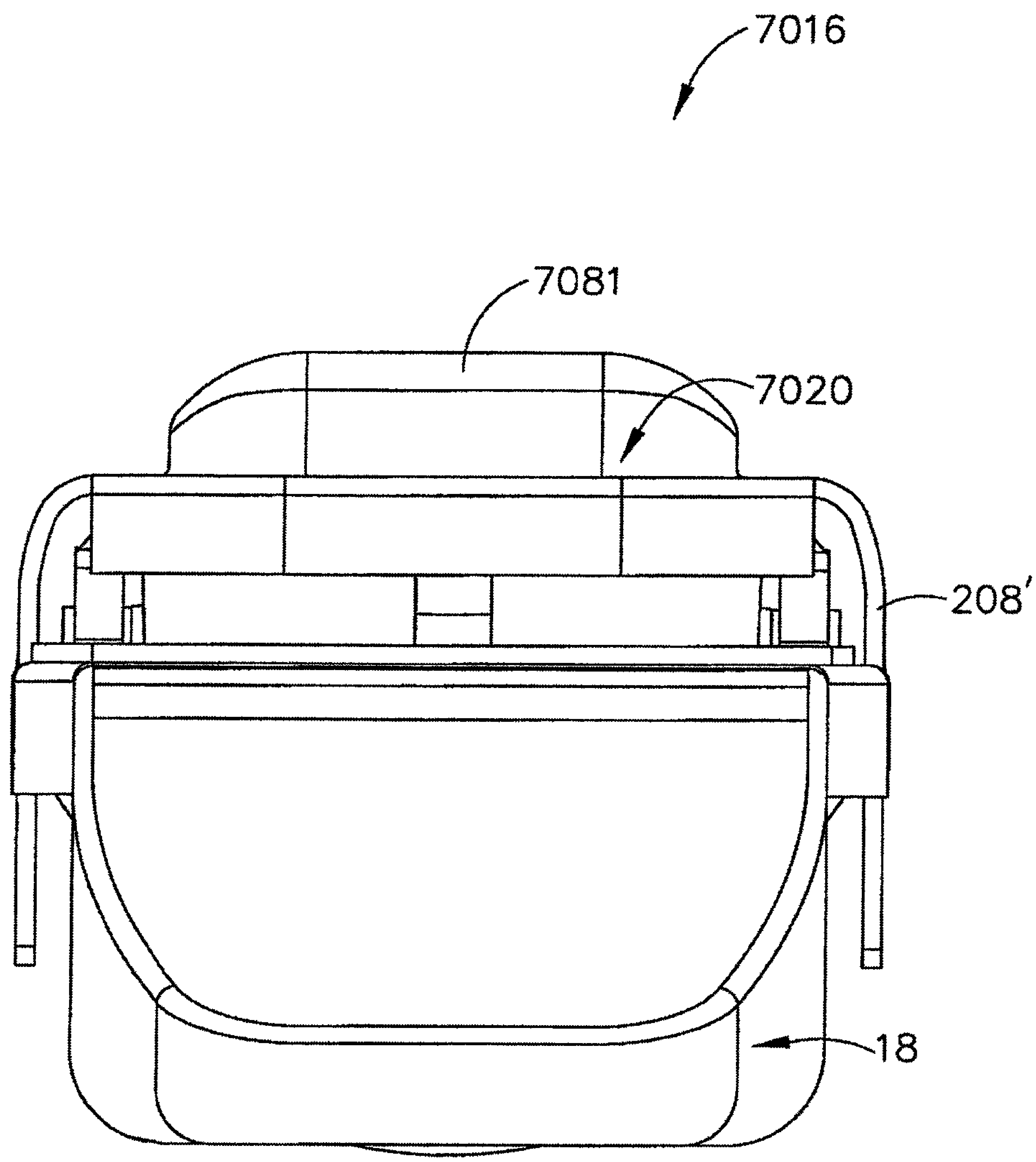


FIG. 92

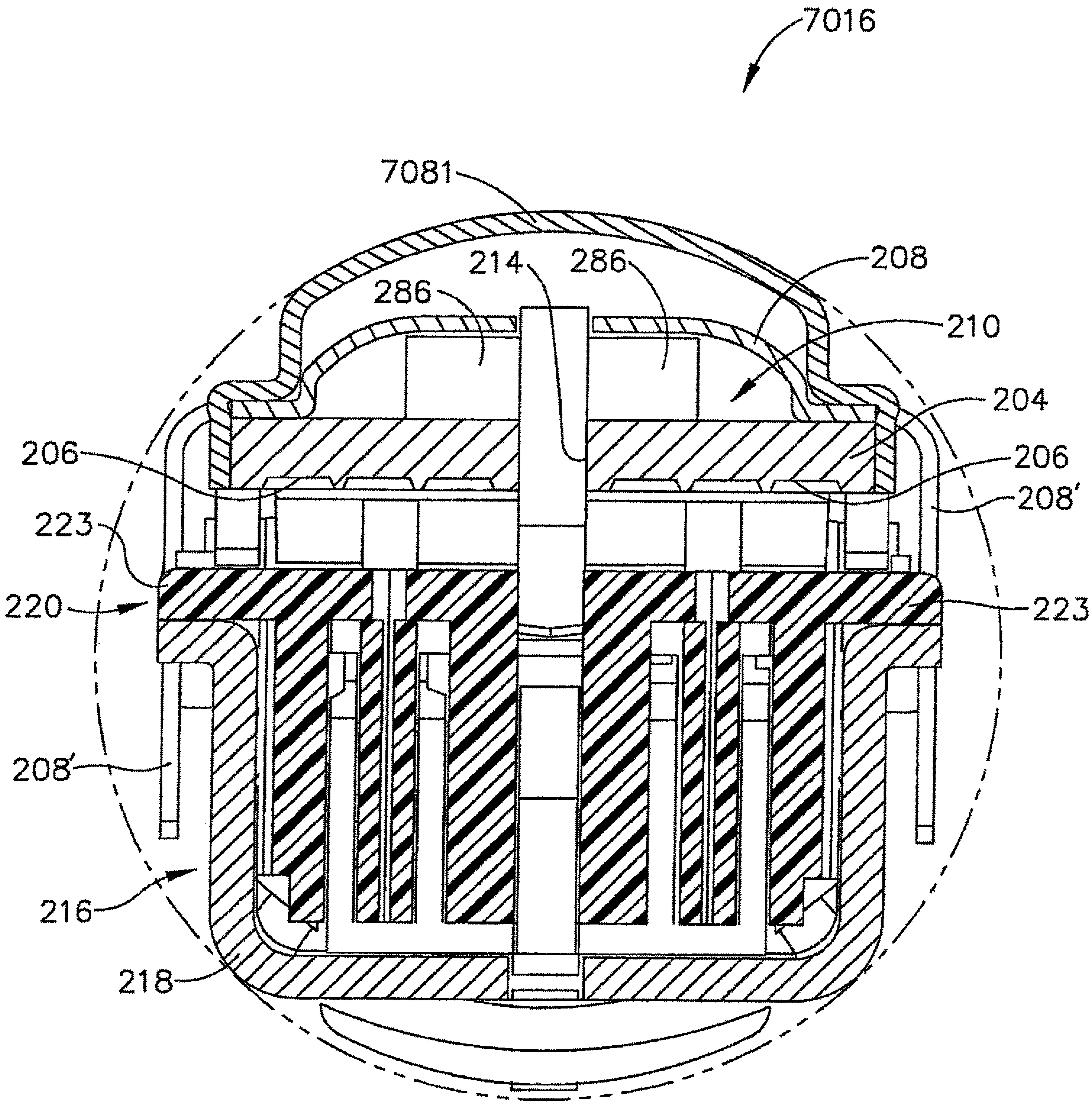

7016
7081
214
286
286
208
210
204
206
206
208'
223
223
220
208'
216
218

FIG. 93

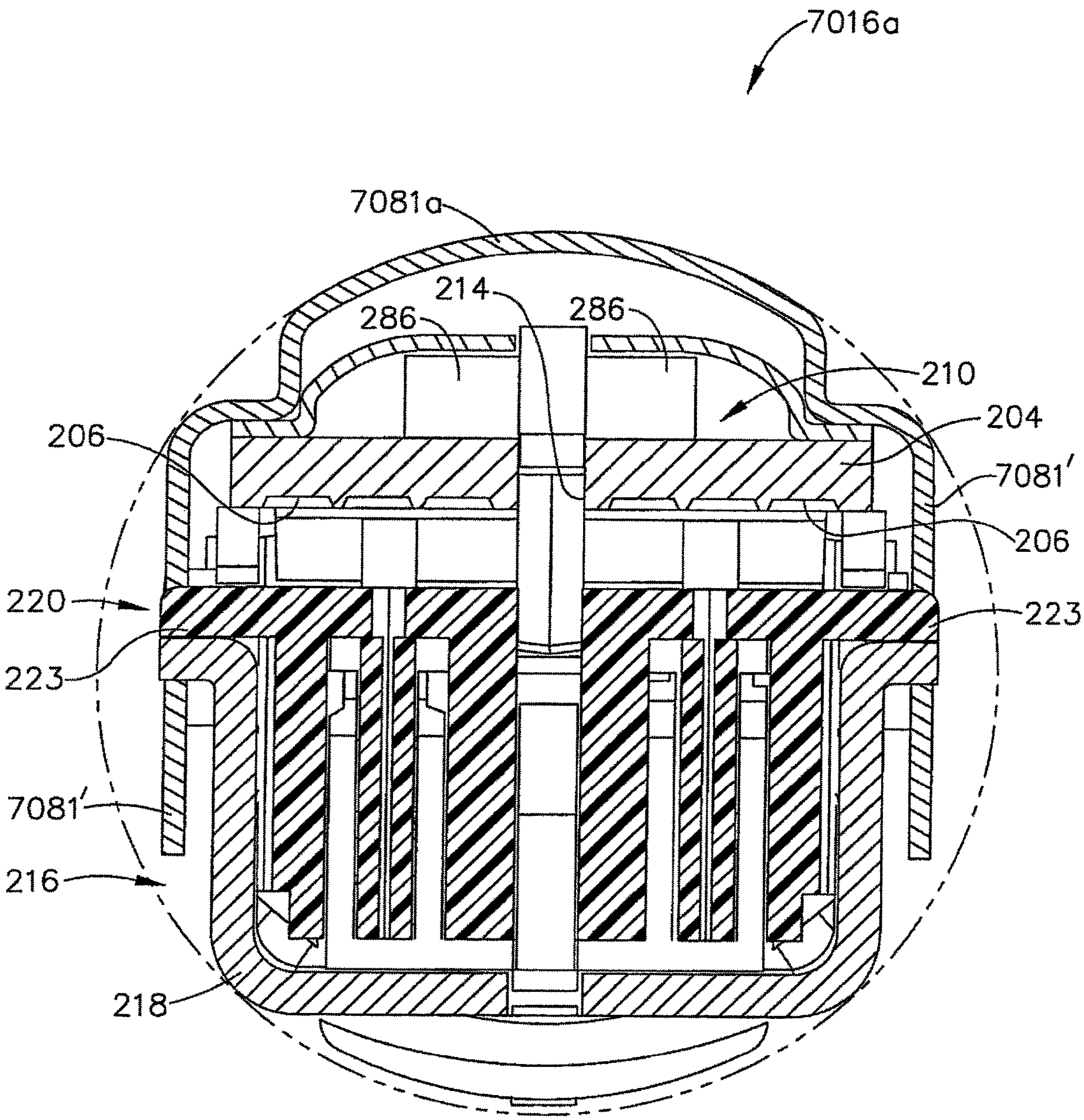

7016a
7081a
214
286
286
210
204
206
7081′
206
220
223
223
7081′
216
218

FIG. 94

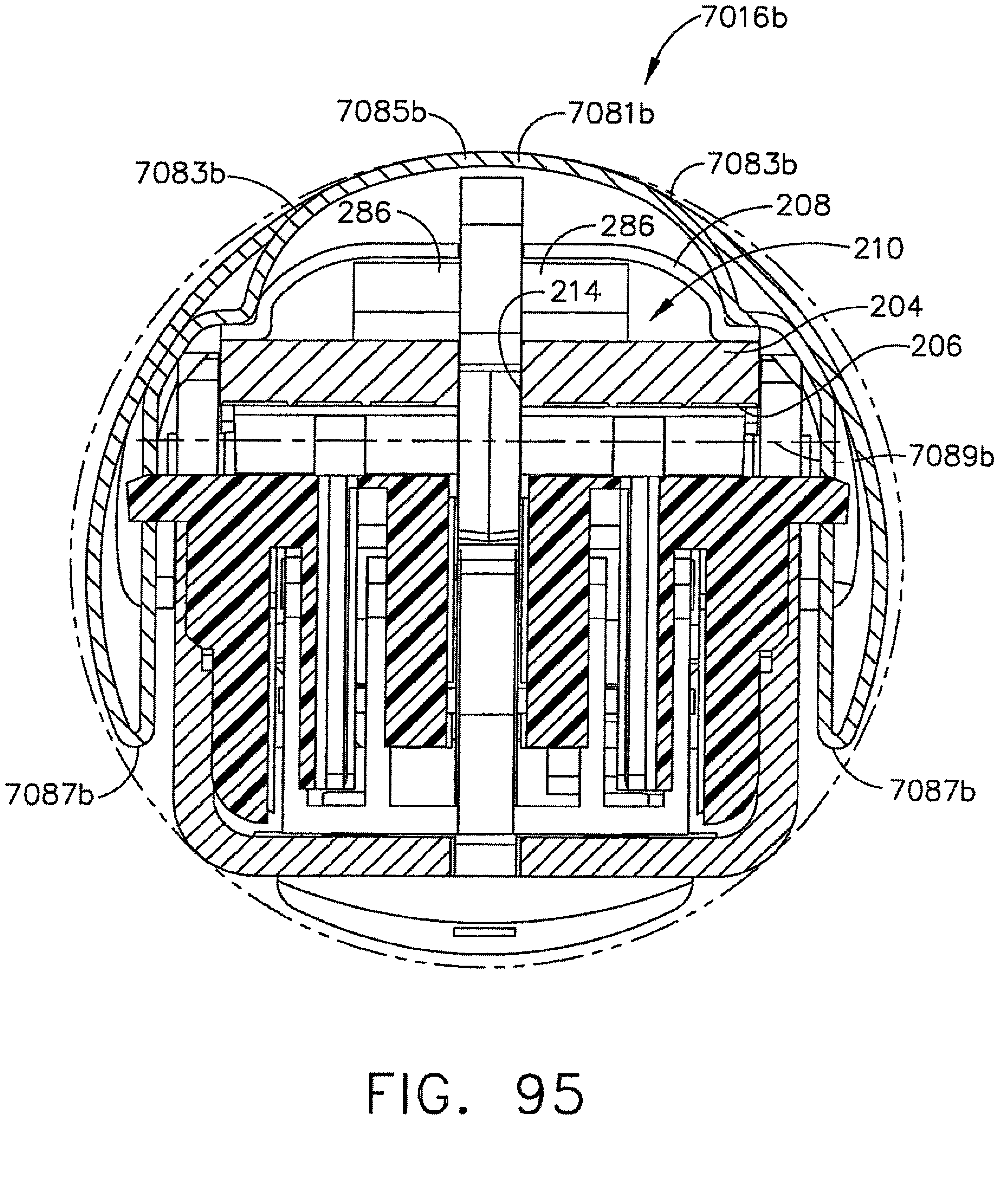

7016b
7085b
7081b
7083b
7083b
286
286
208
210
214
204
206
7089b
7087b
7087b

FIG. 95

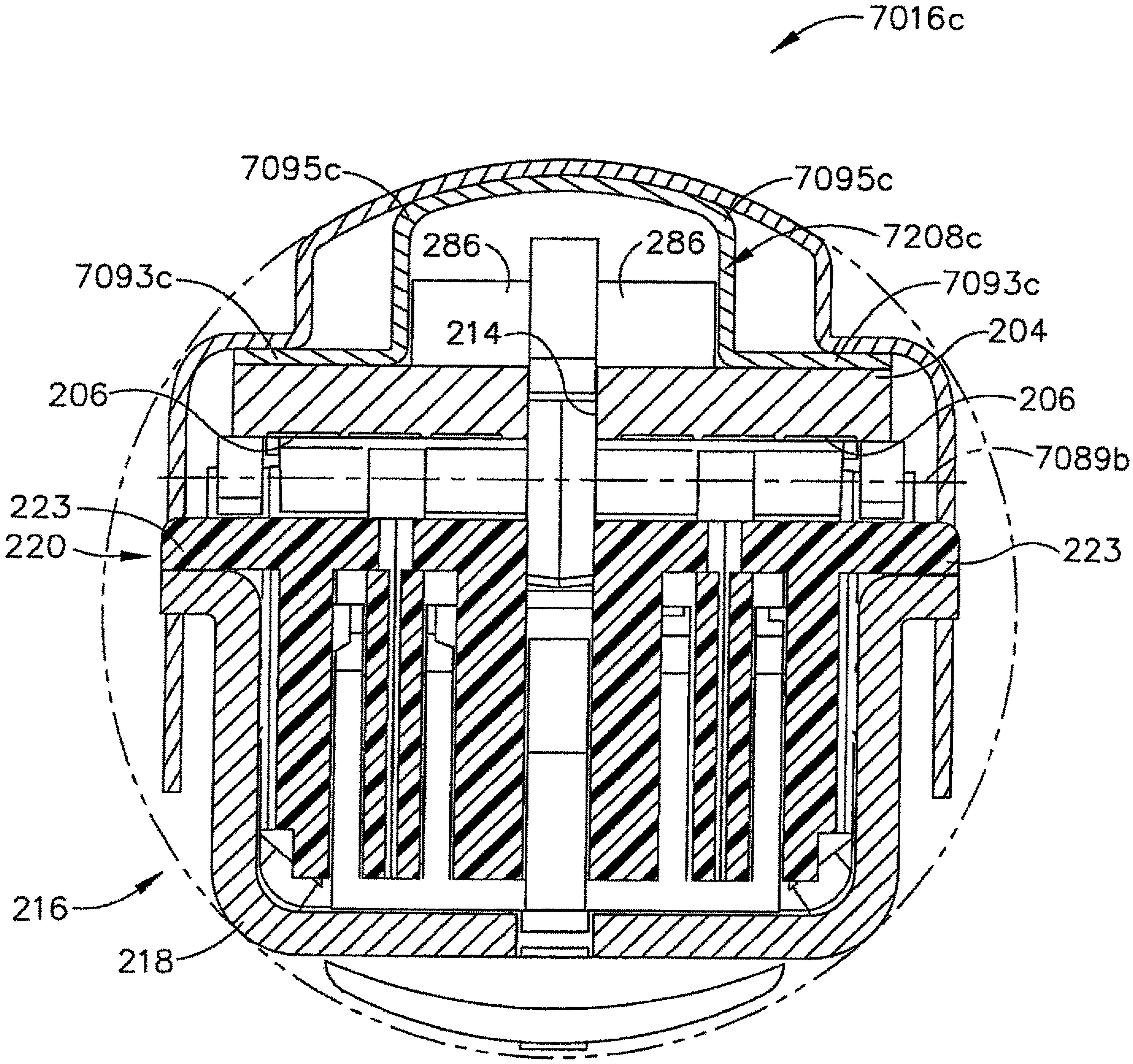

7016c
7095c
7095c
7208c
286
286
7093c
7093c
214
204
206
206
7089b
223
220
223
216
218

FIG. 96

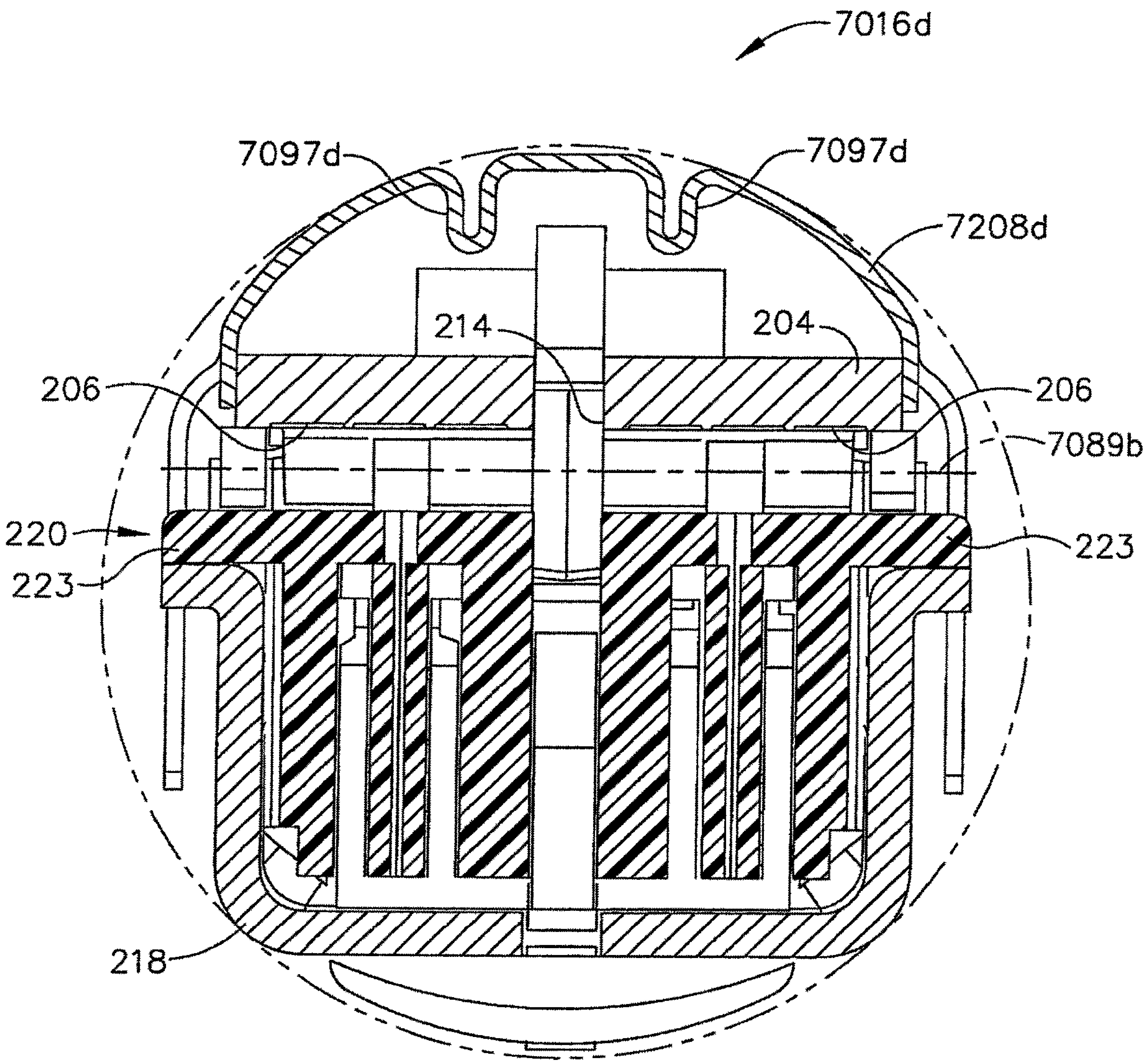


FIG. 97

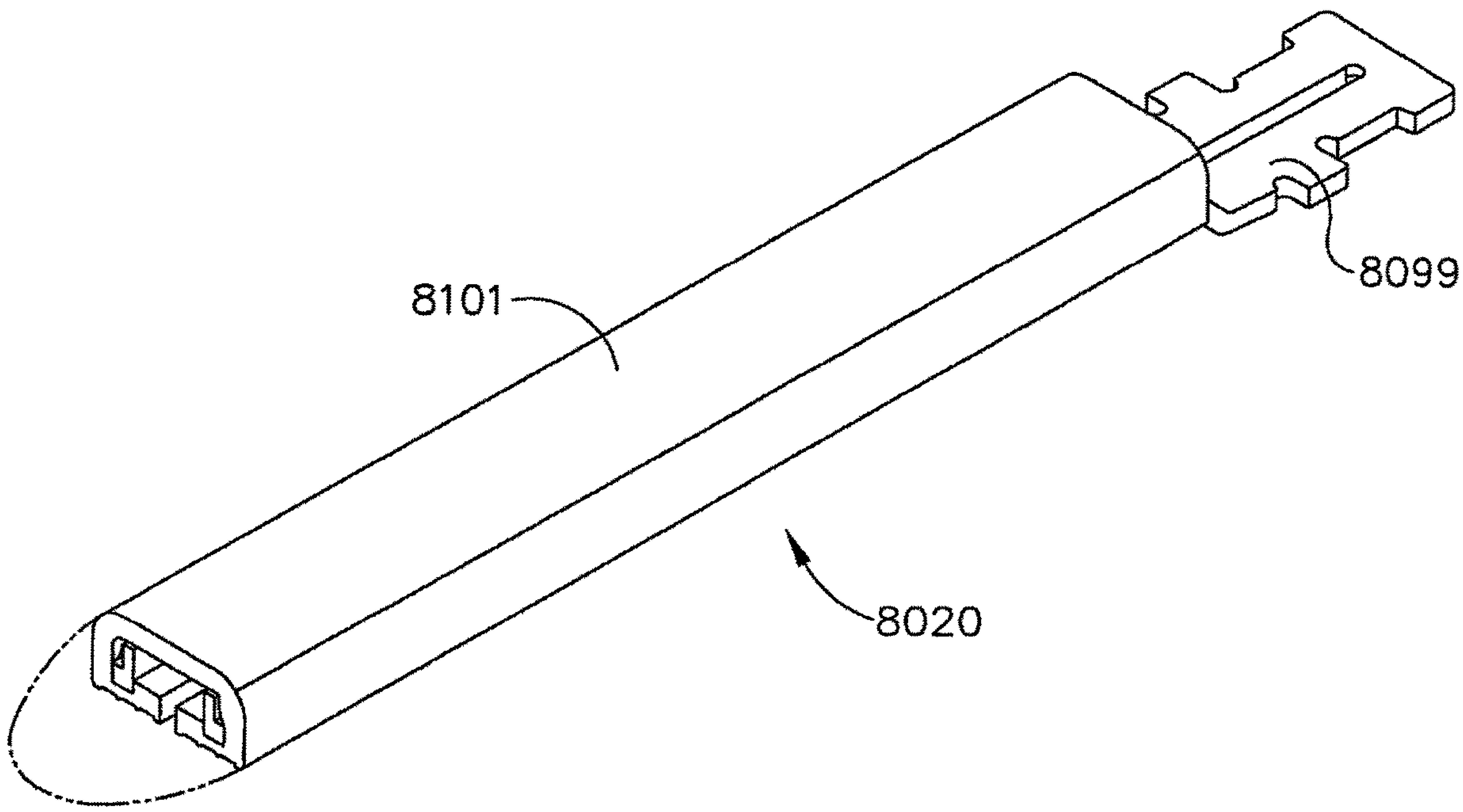


FIG. 98

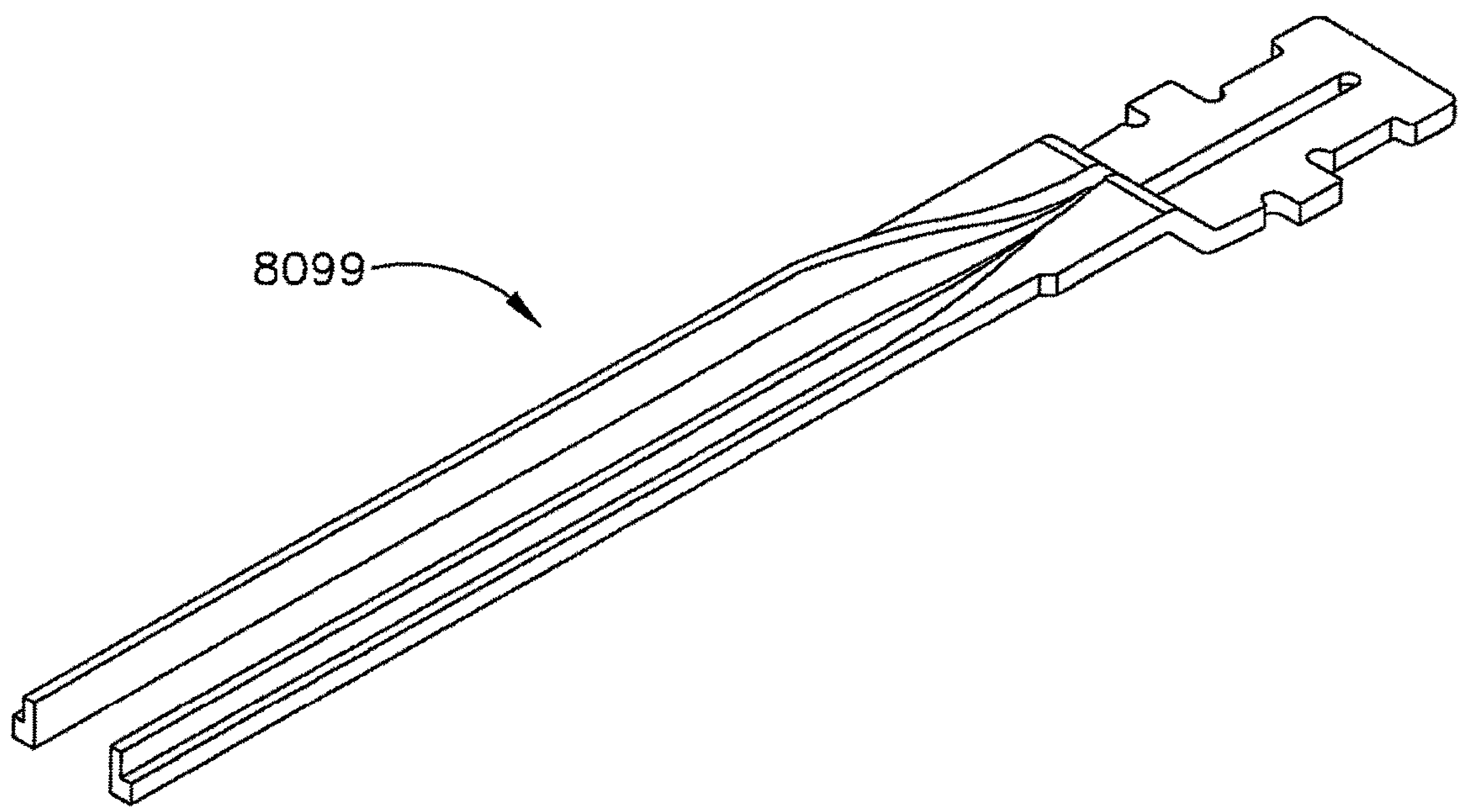


FIG. 99

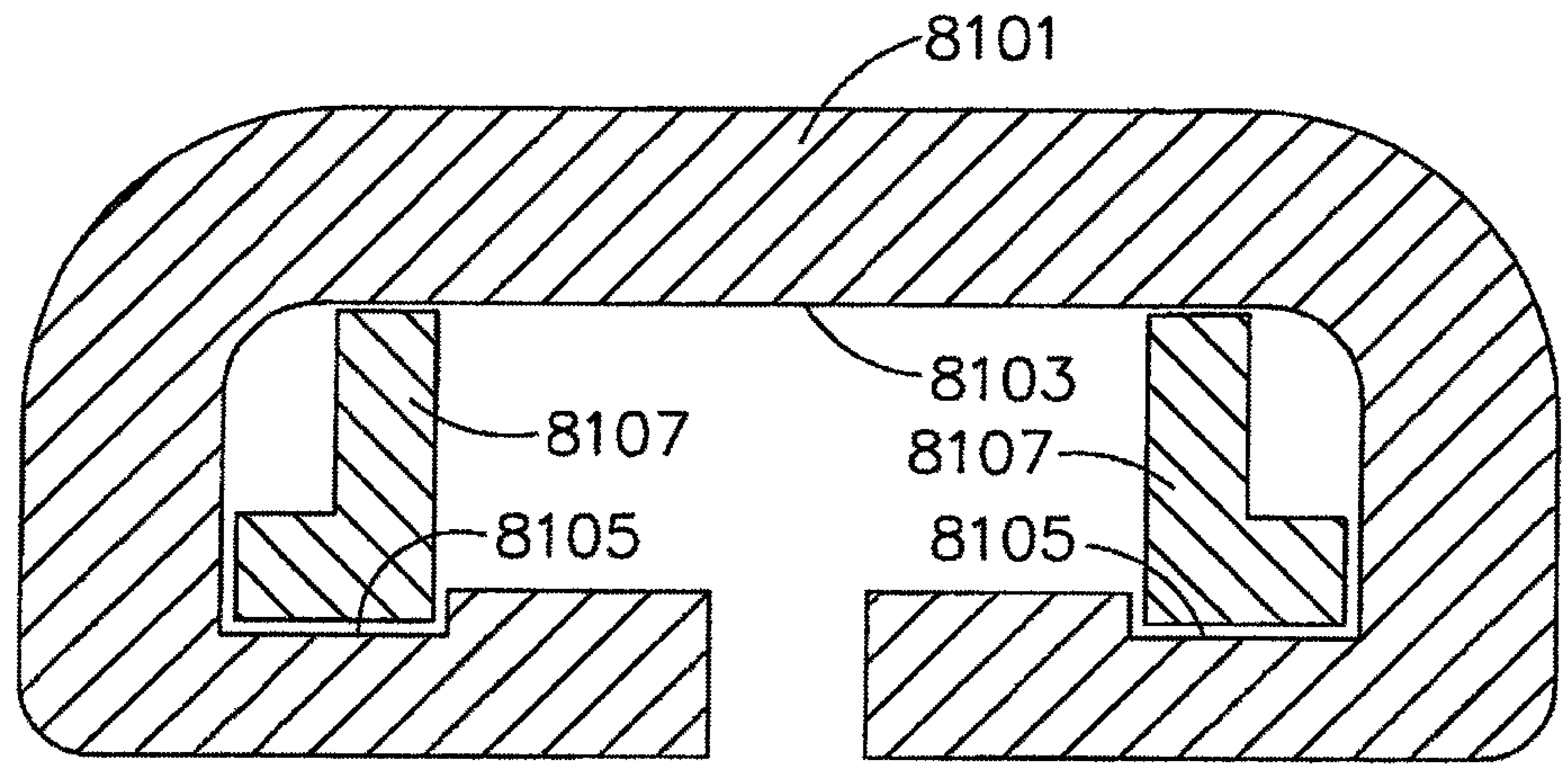


FIG. 100

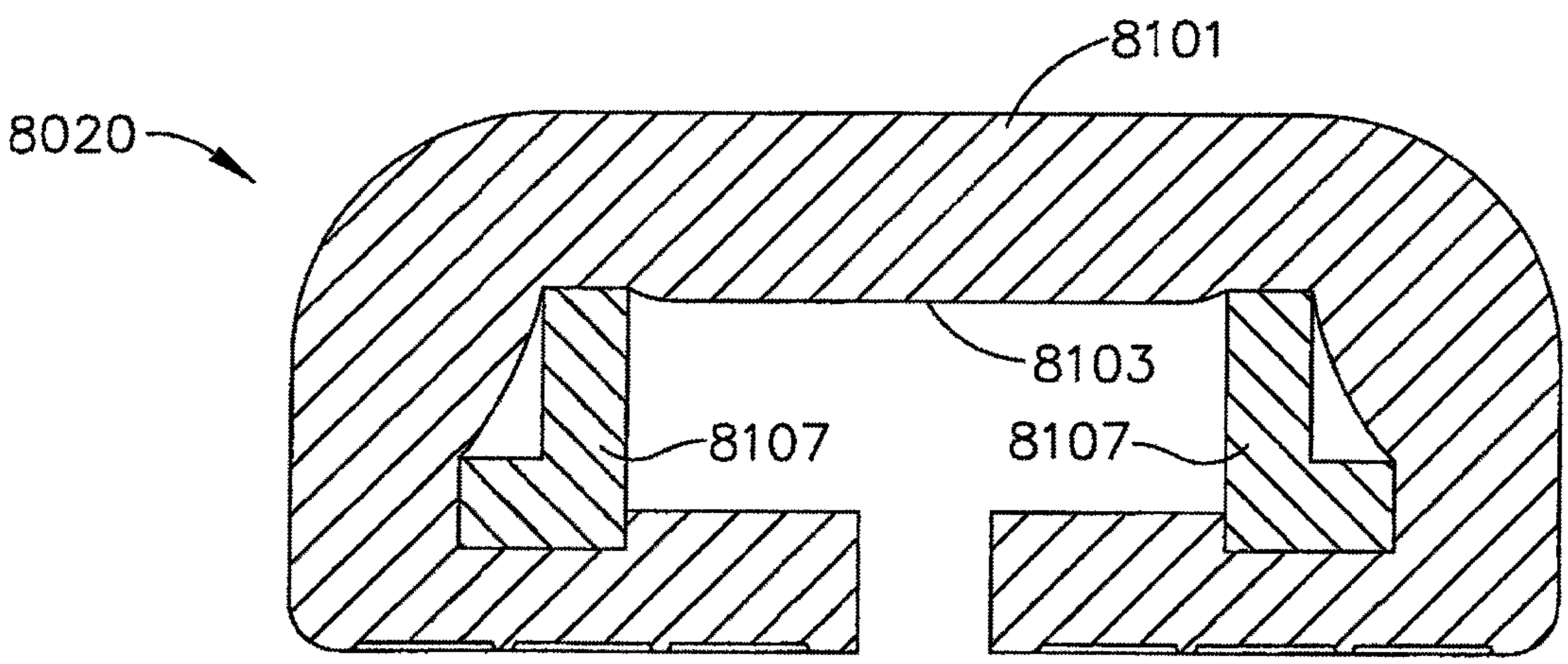


FIG. 101

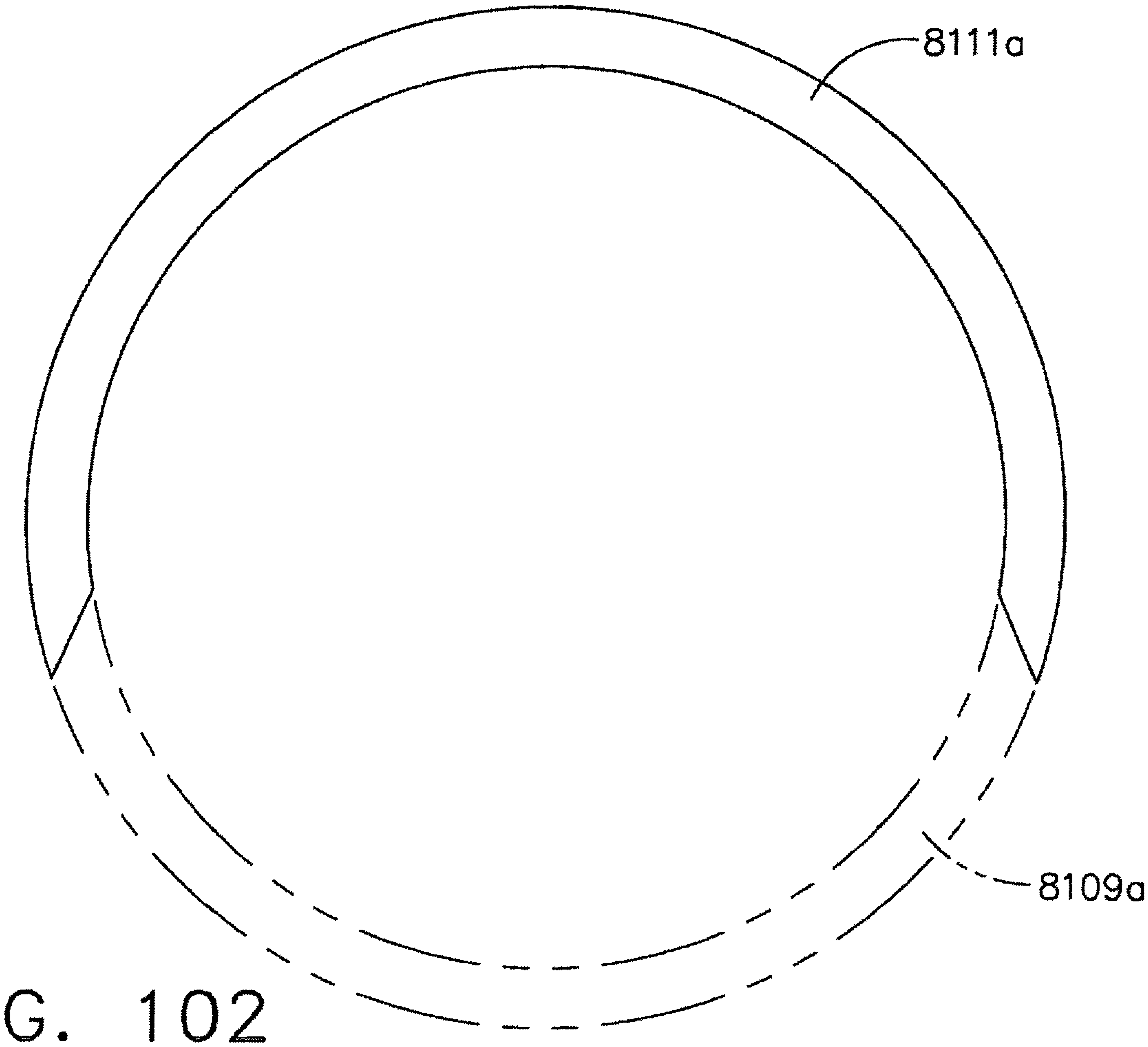


FIG. 102

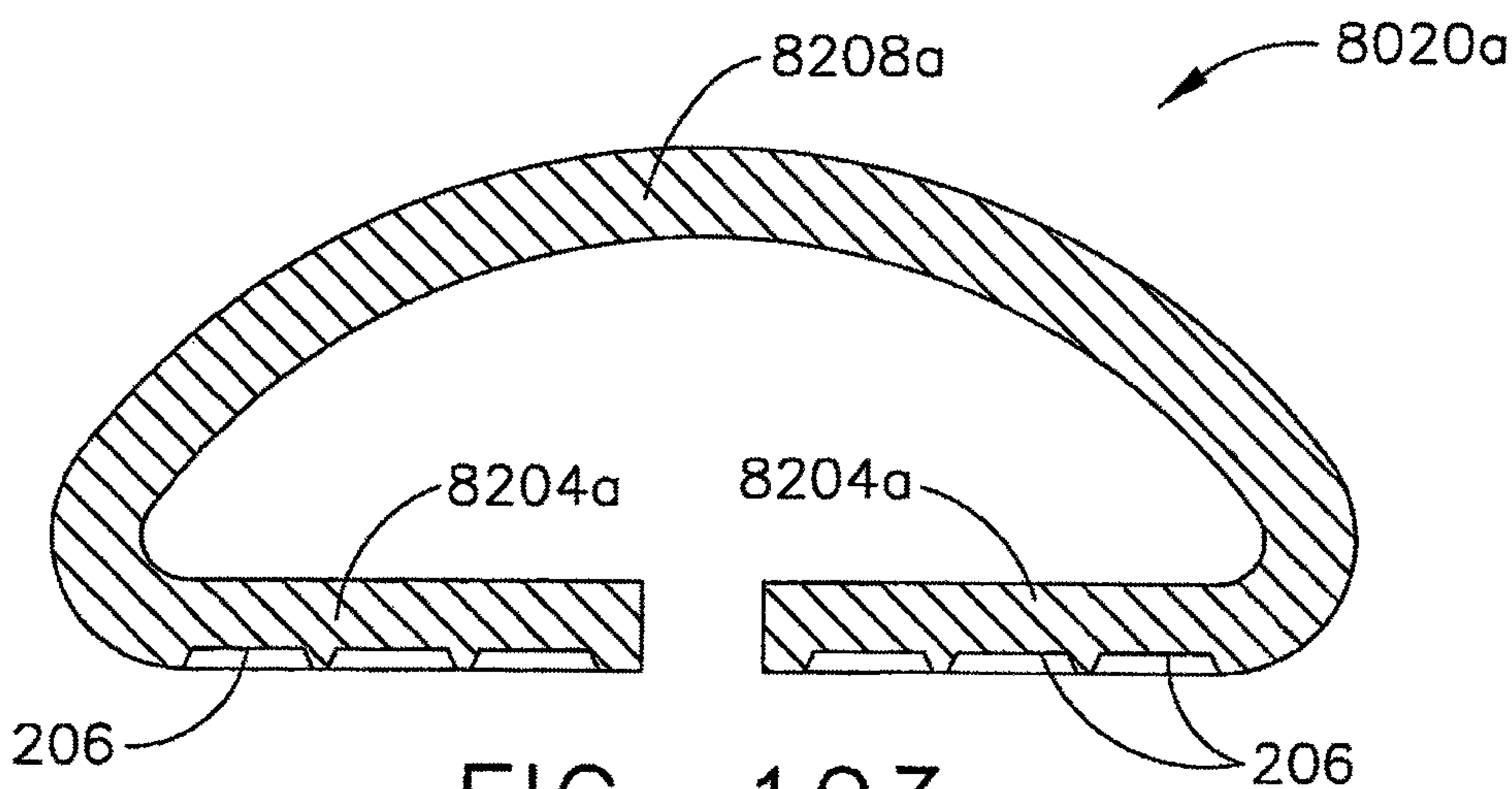


FIG. 103

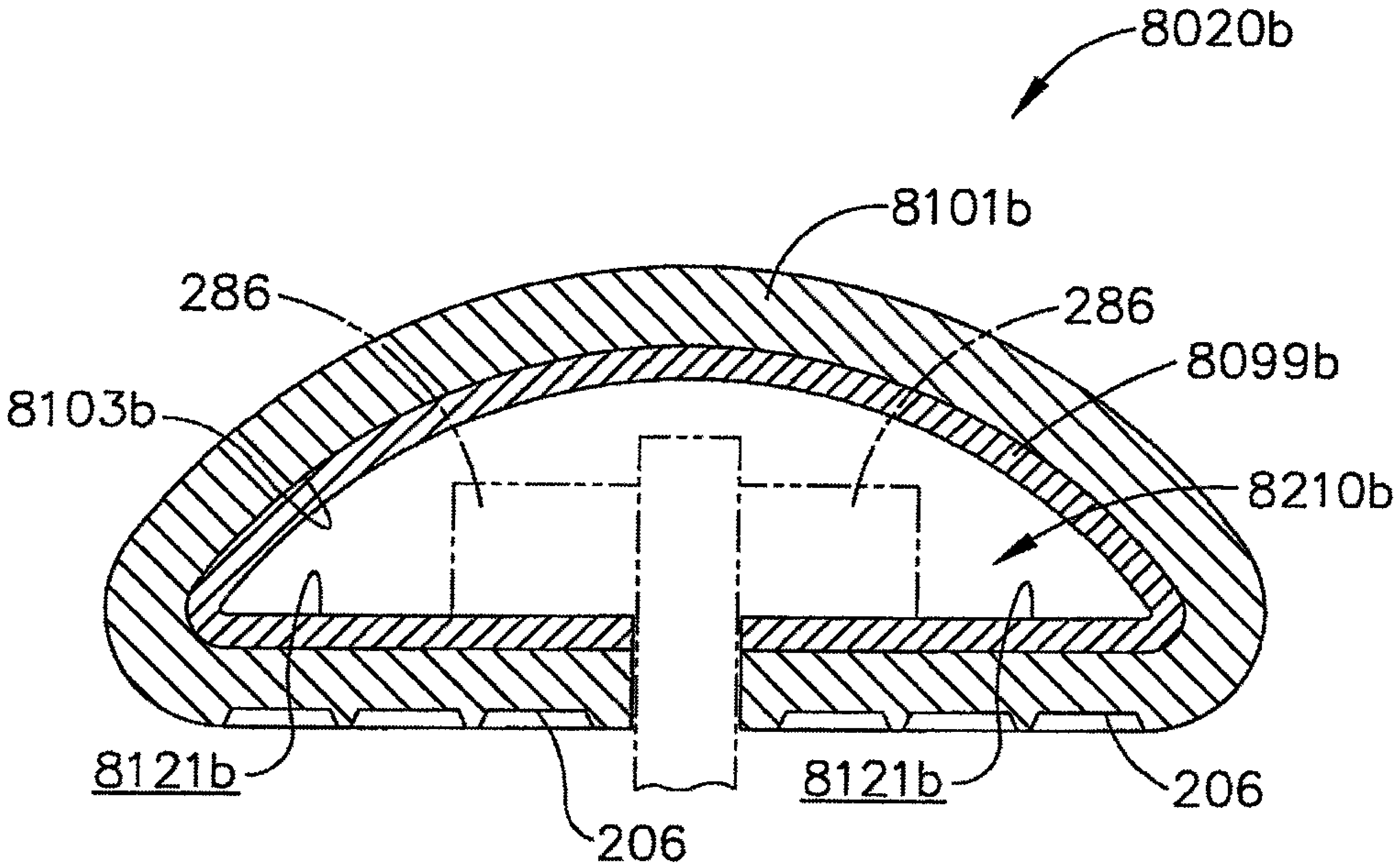


FIG. 104

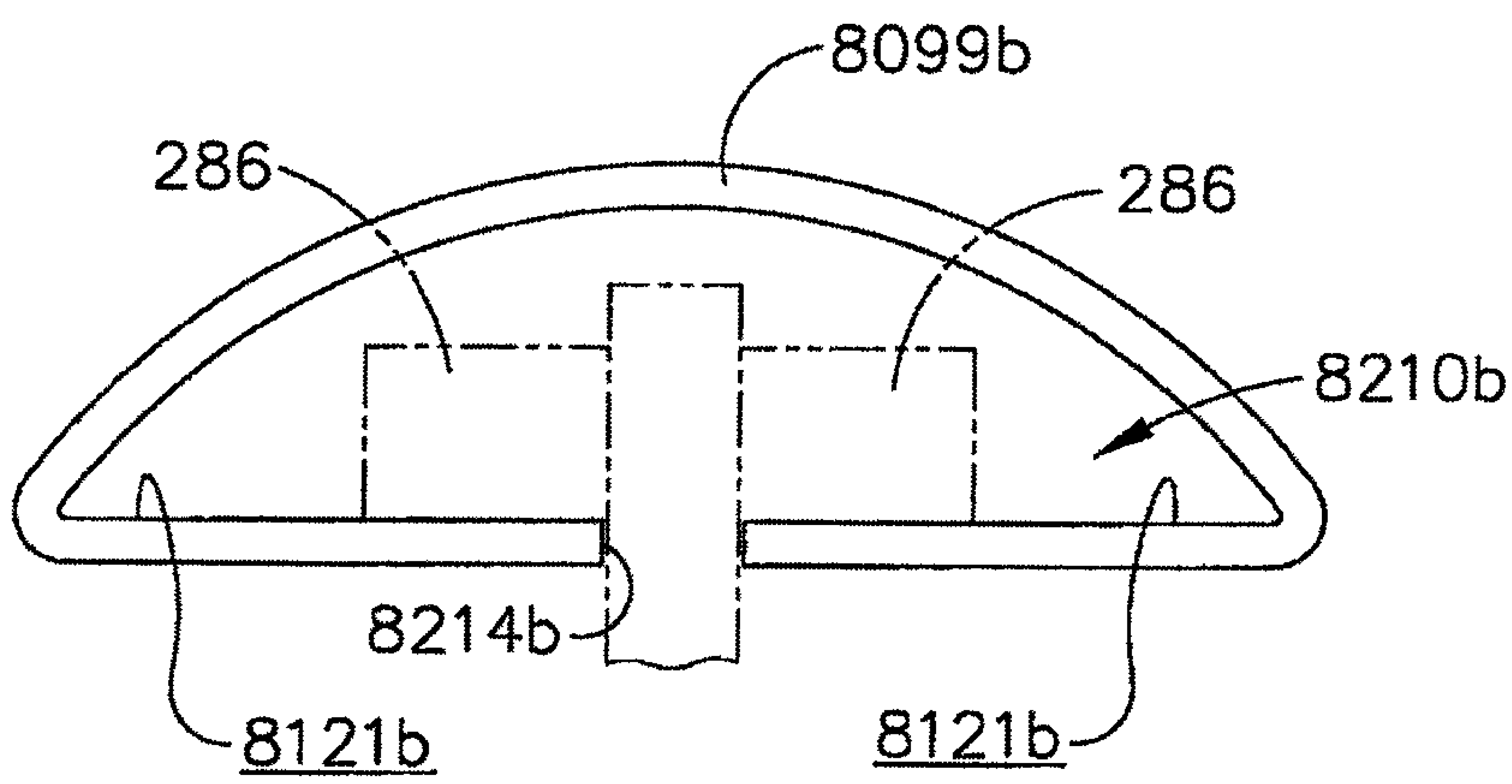


FIG. 105

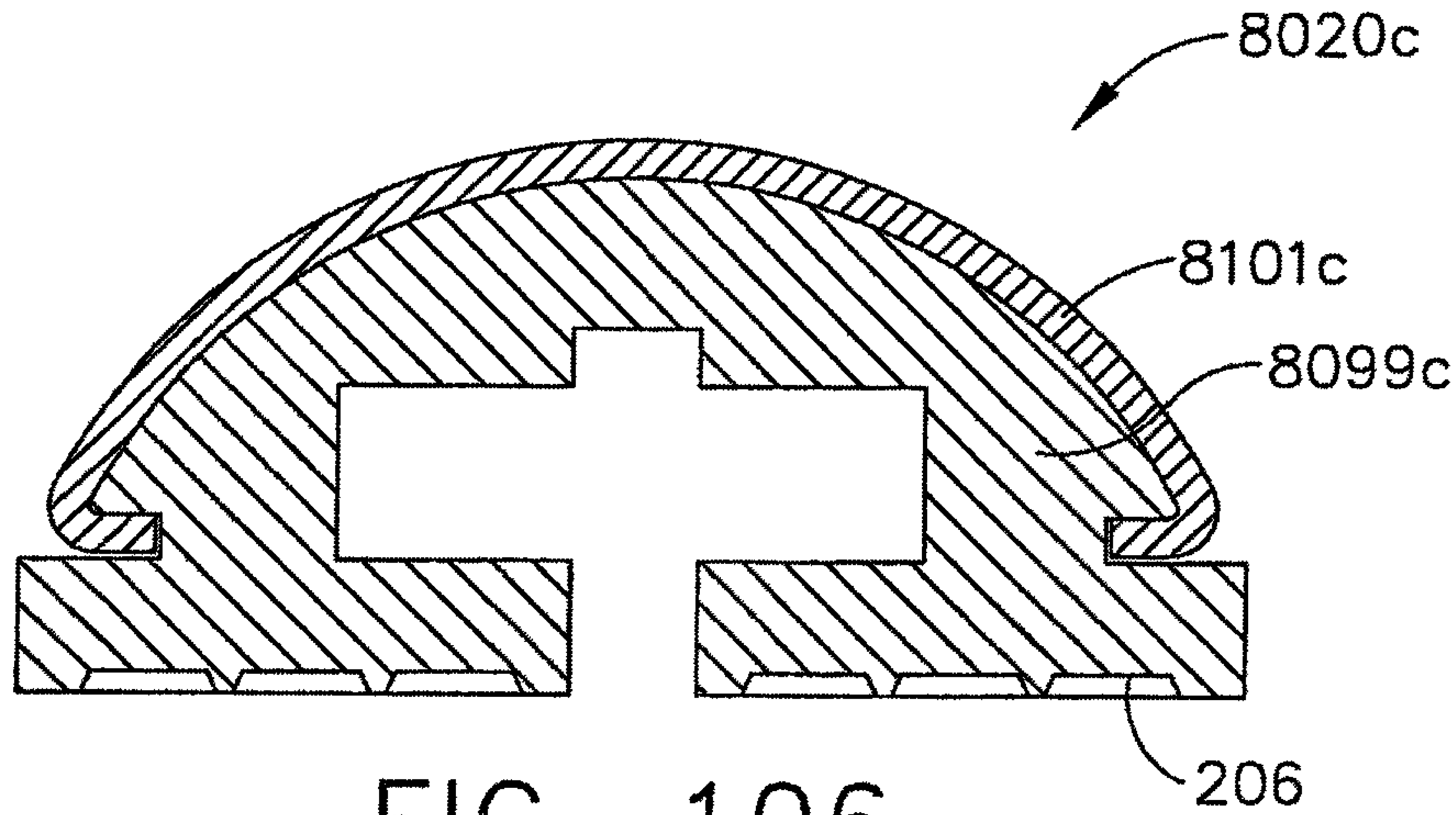


FIG. 106

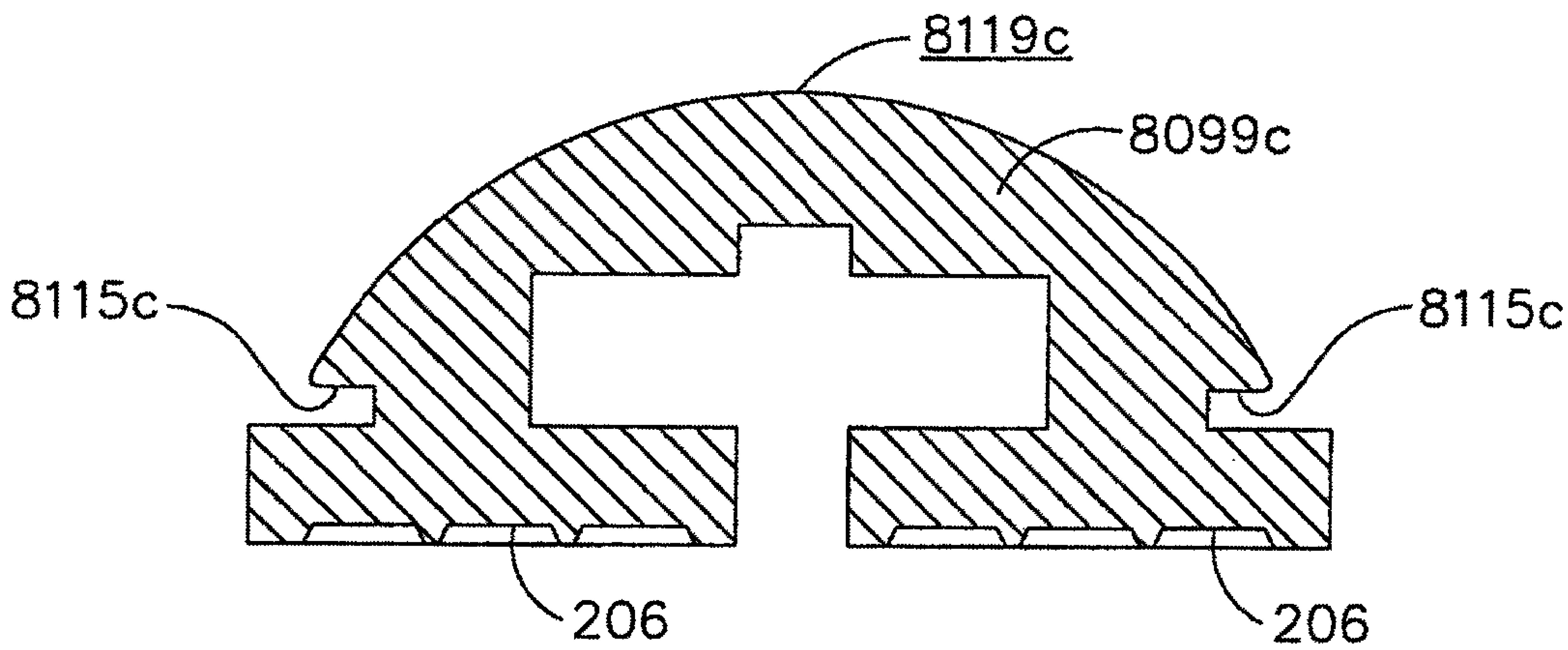


FIG. 107

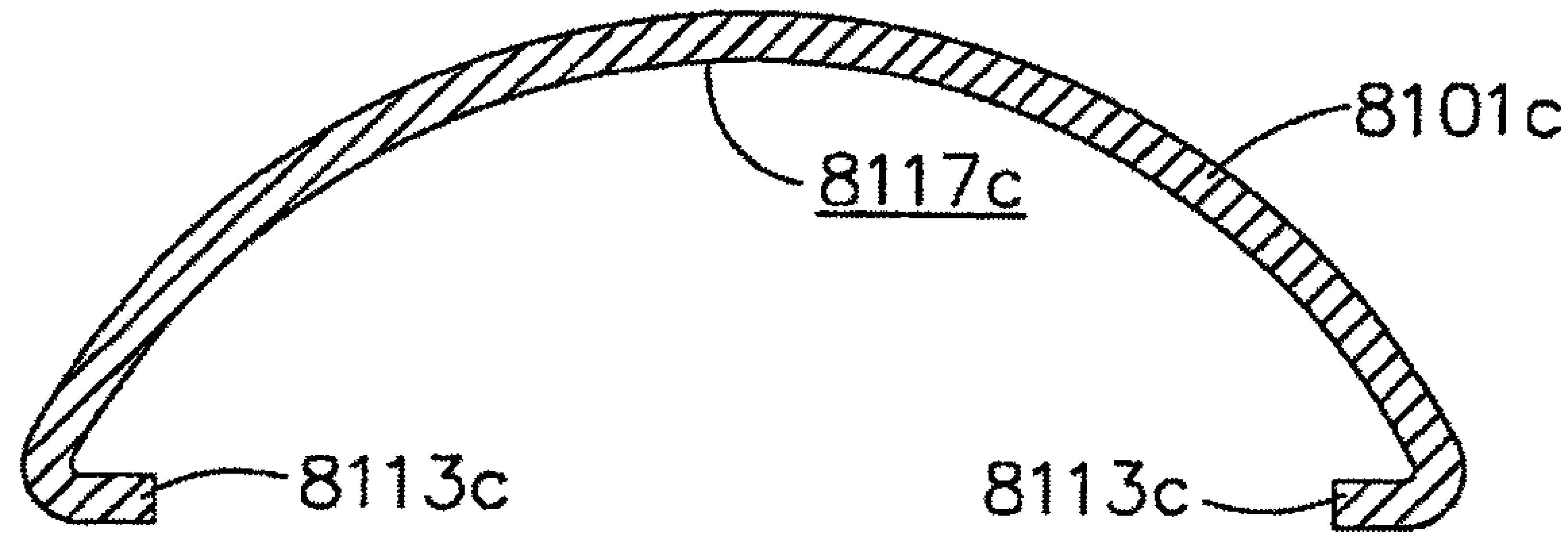


FIG. 108

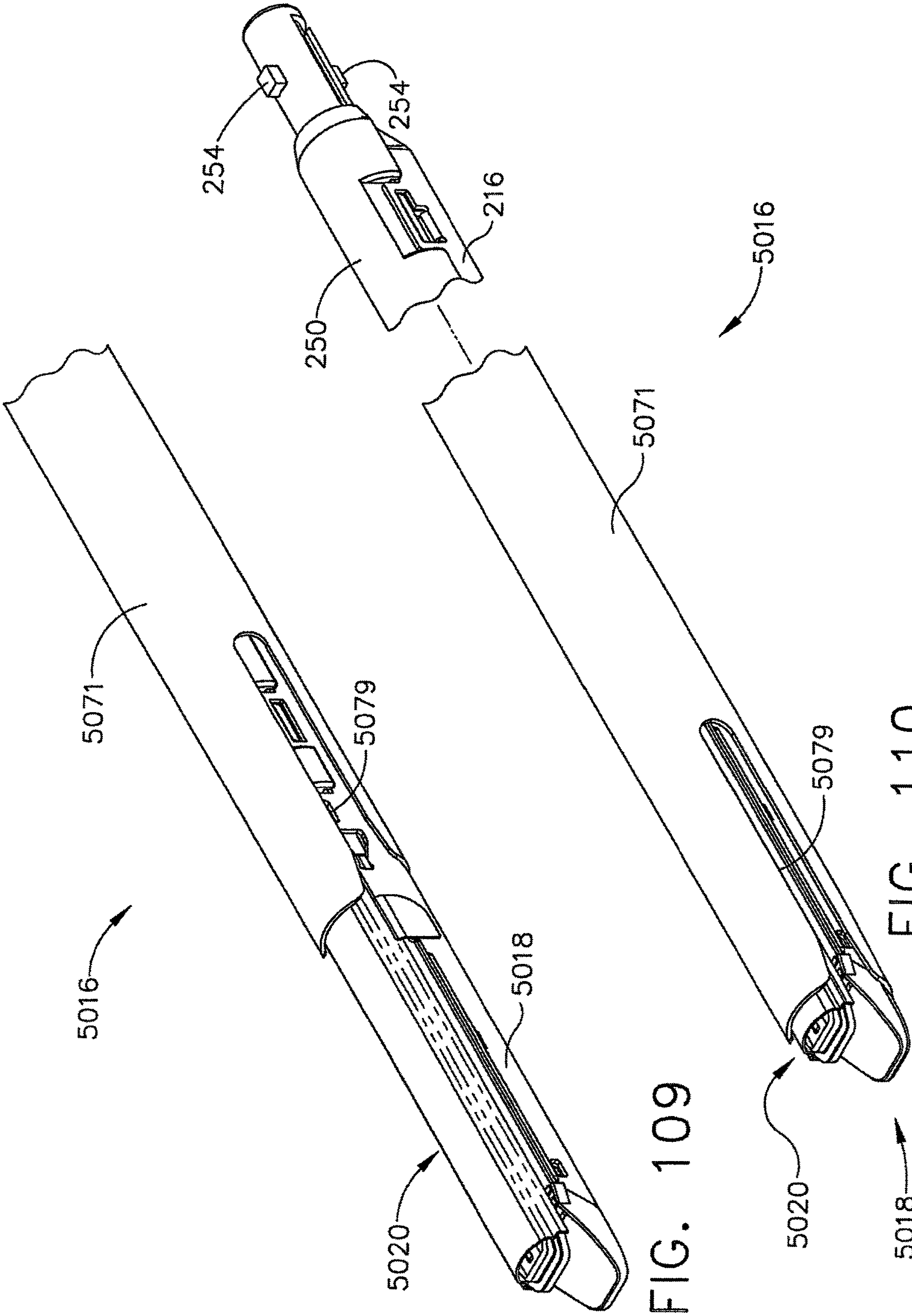


FIG. 109

FIG. 110

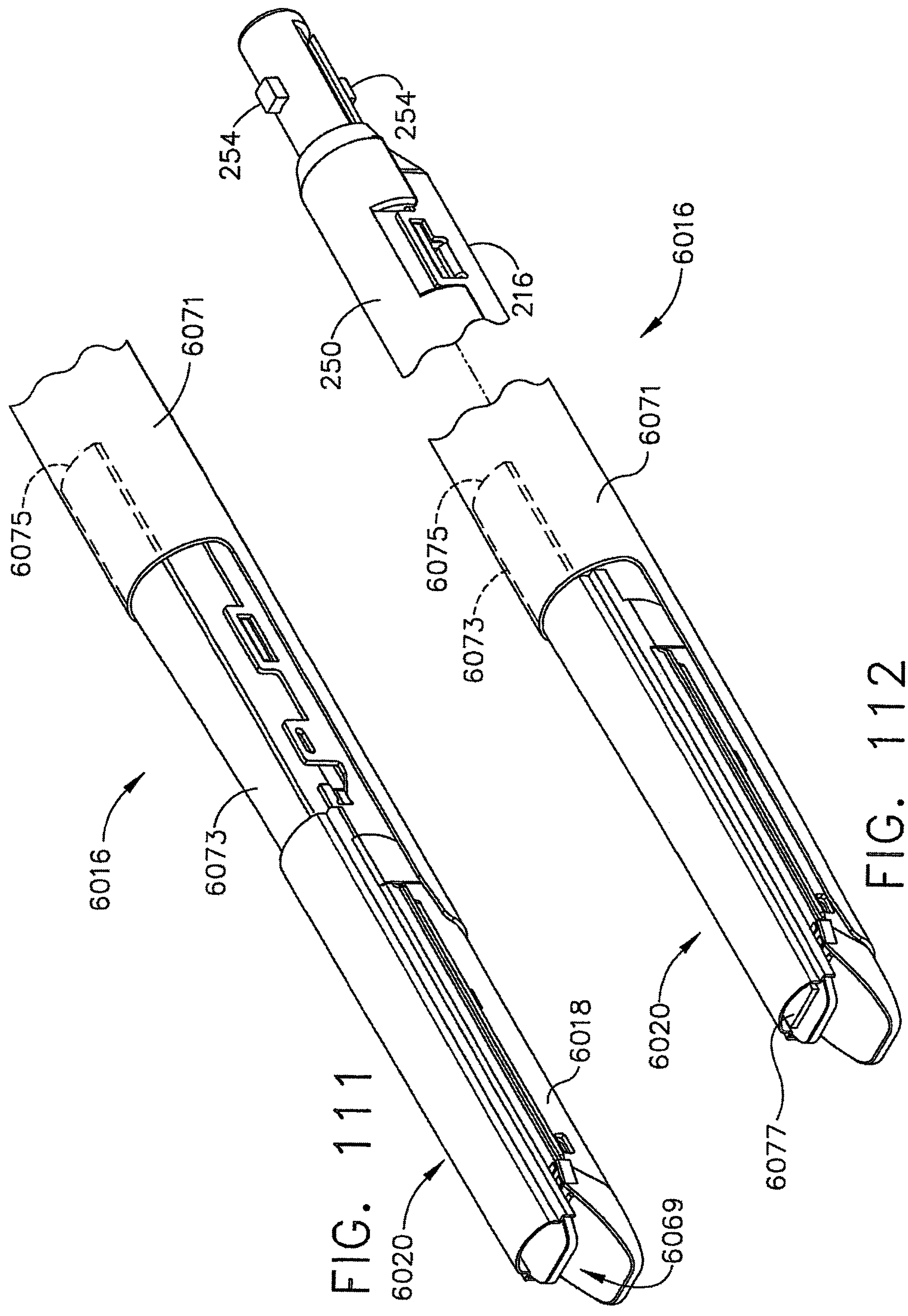


FIG. 111

FIG. 112

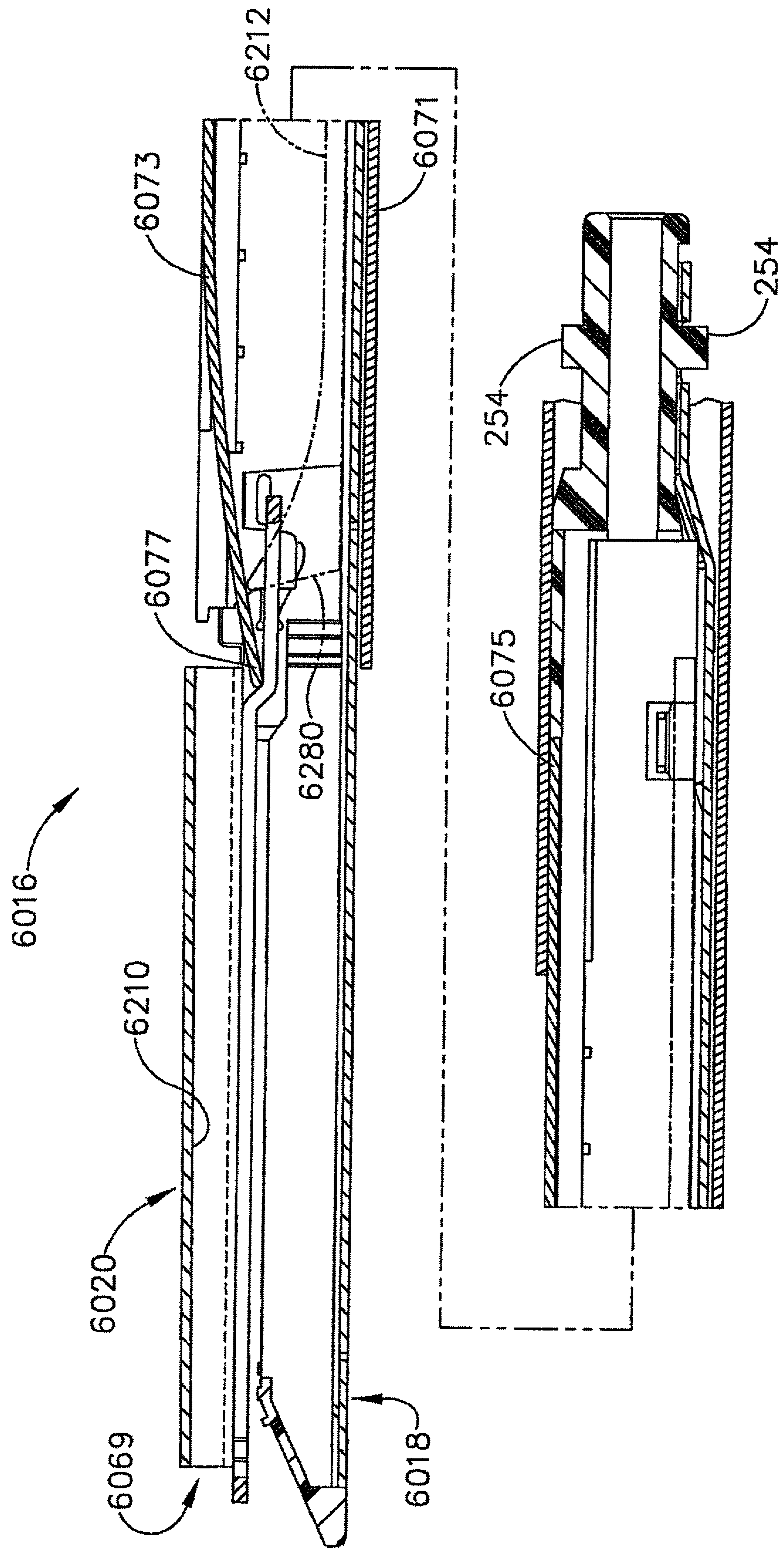

6212
6071
6073
254
254
6077
6075
6280
6016
6210
6020
6069
6018

FIG. 113

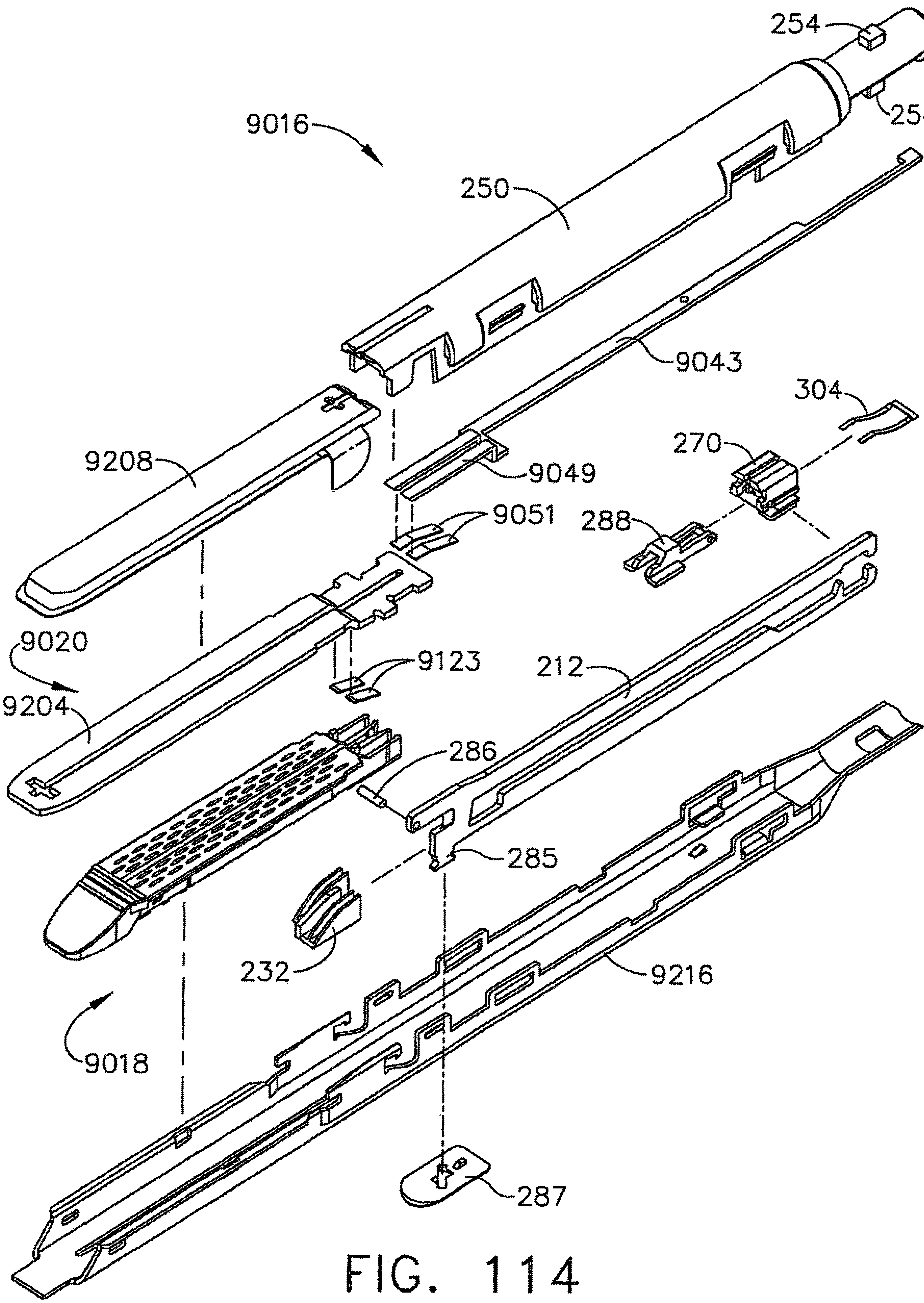

254
254
9016
250
9043
304
270
9208
9049
9051
288
9020
9123
212
9204
286
285
232
9216
9018
287

FIG. 114

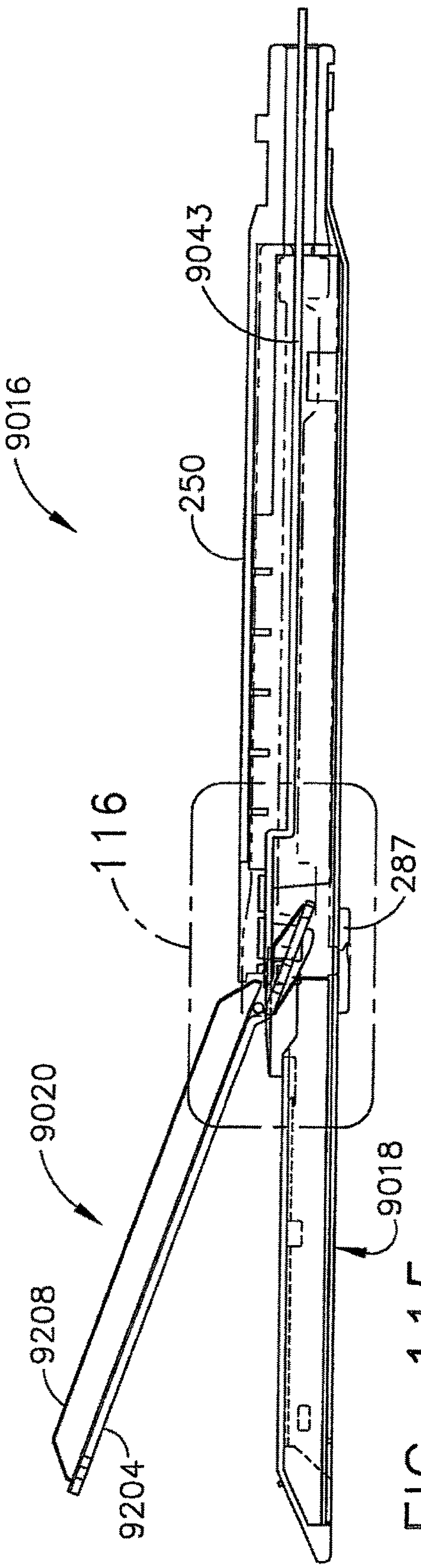


FIG. 115

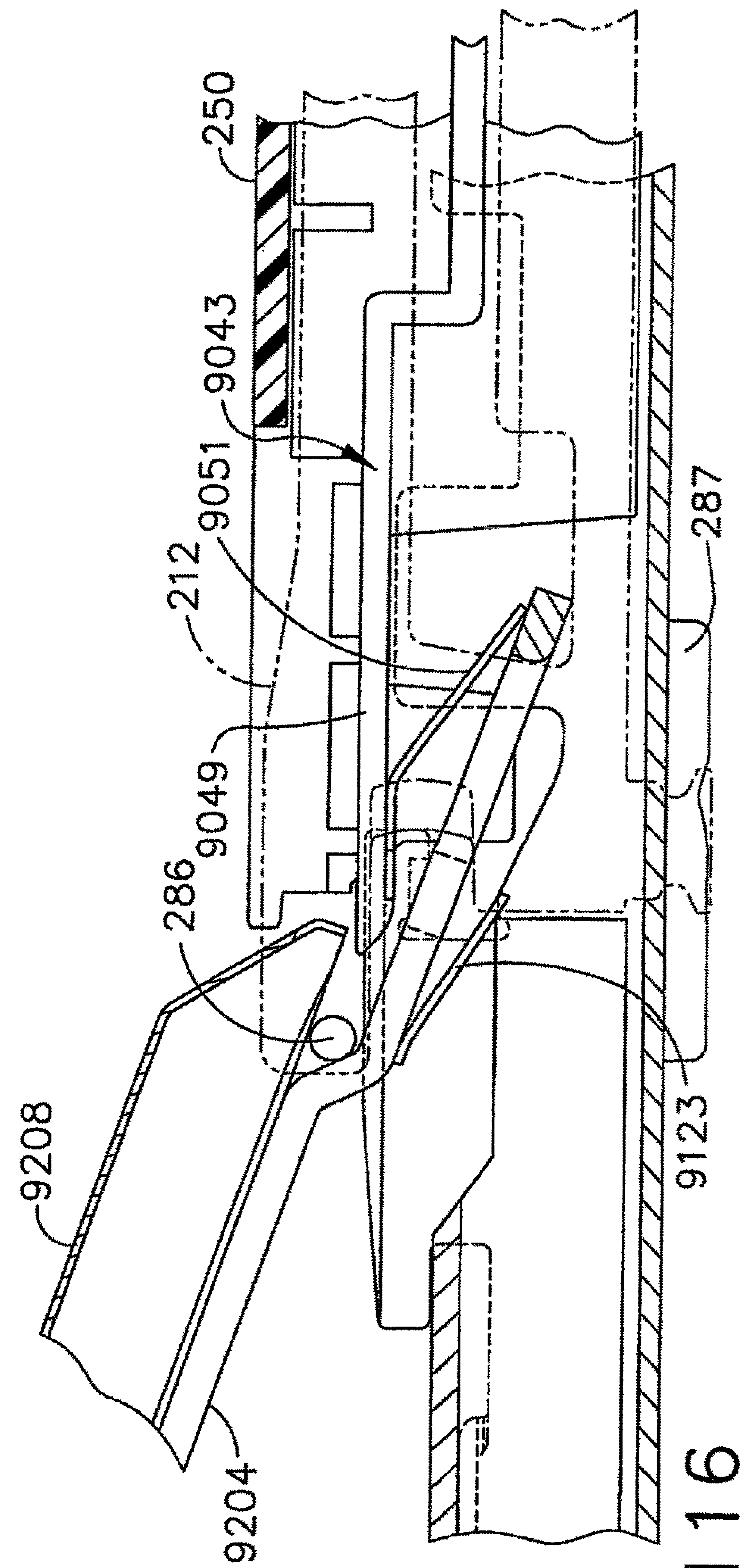


FIG. 116

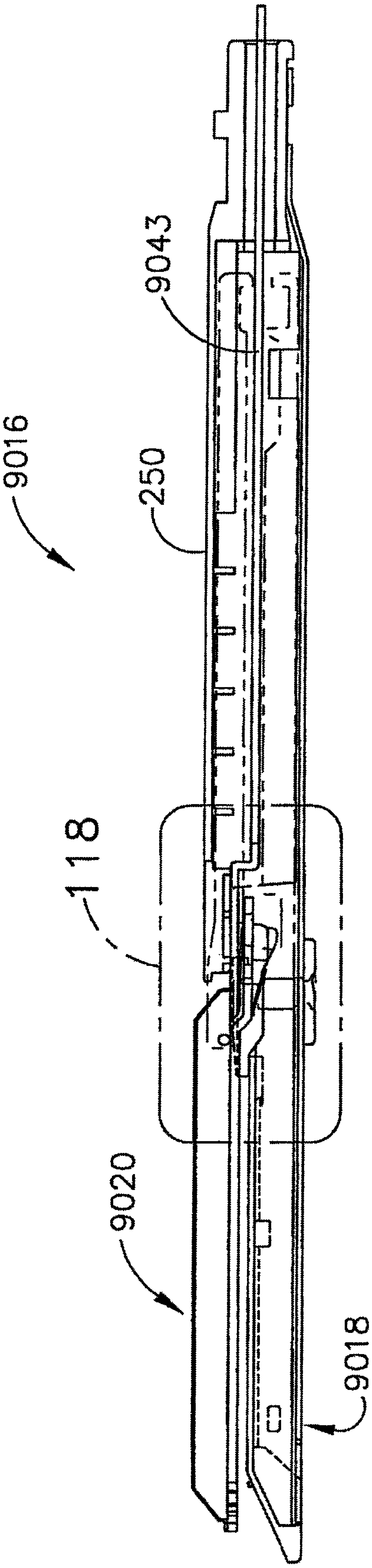


FIG. 117

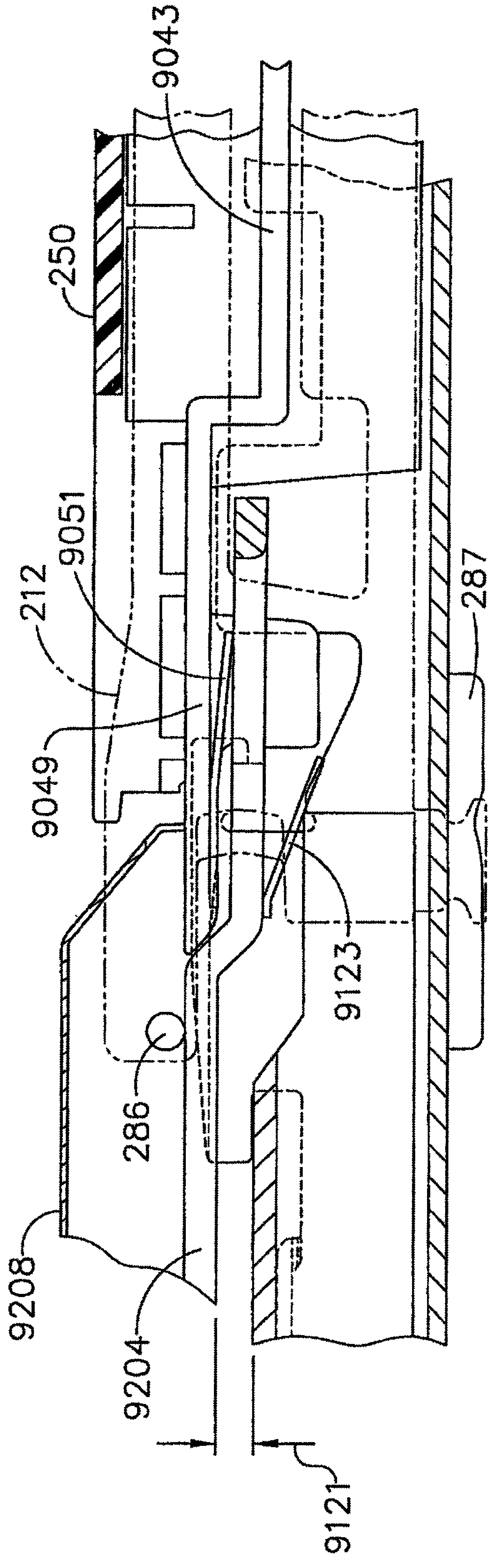


FIG. 118

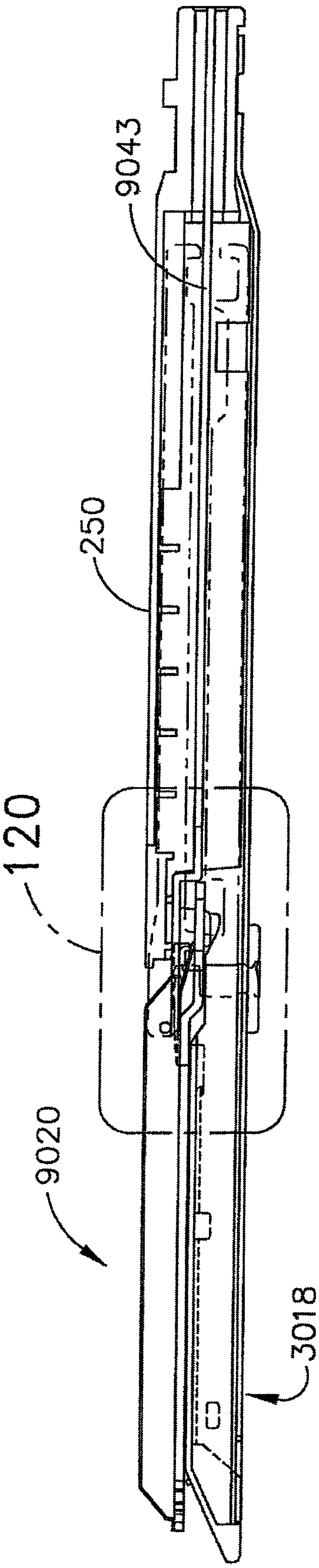


FIG. 119

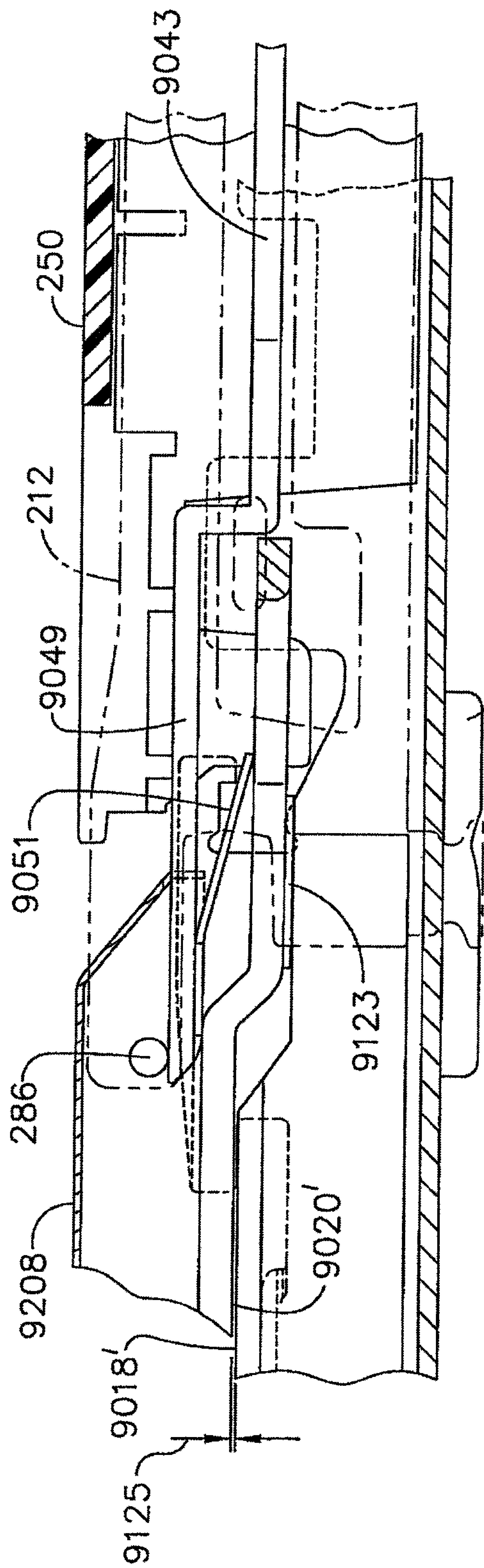


FIG. 120

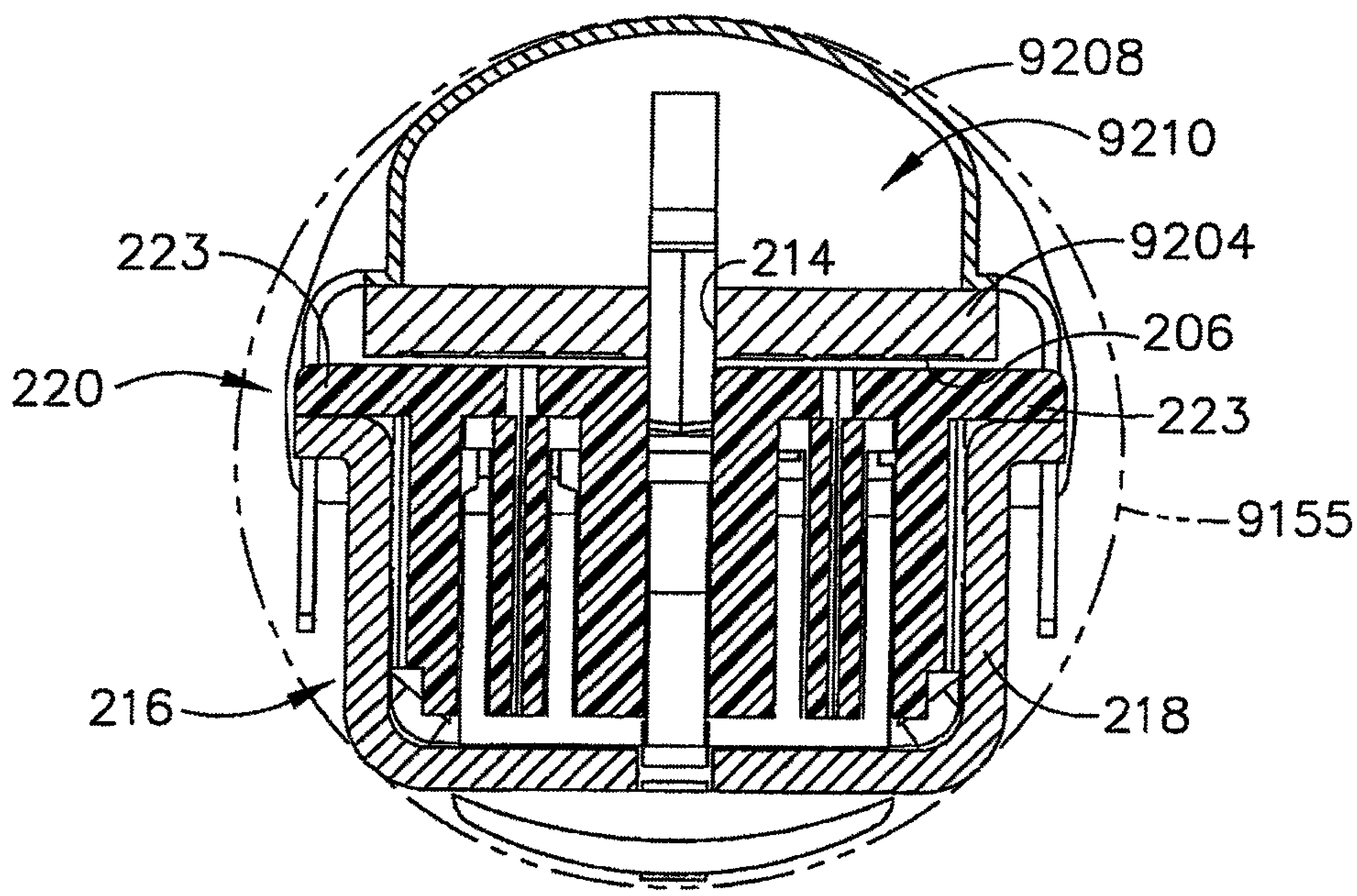


FIG. 121

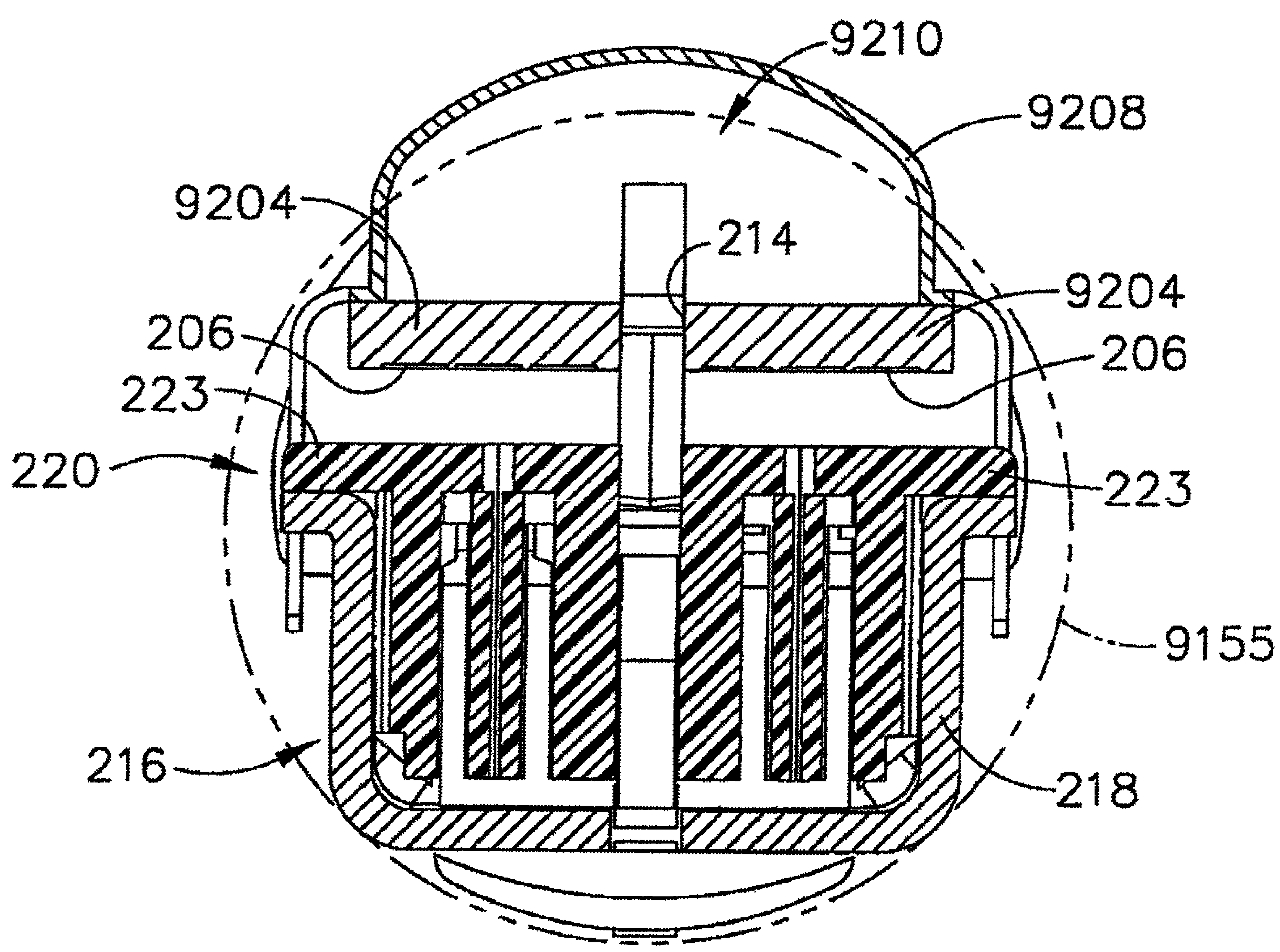


FIG. 122

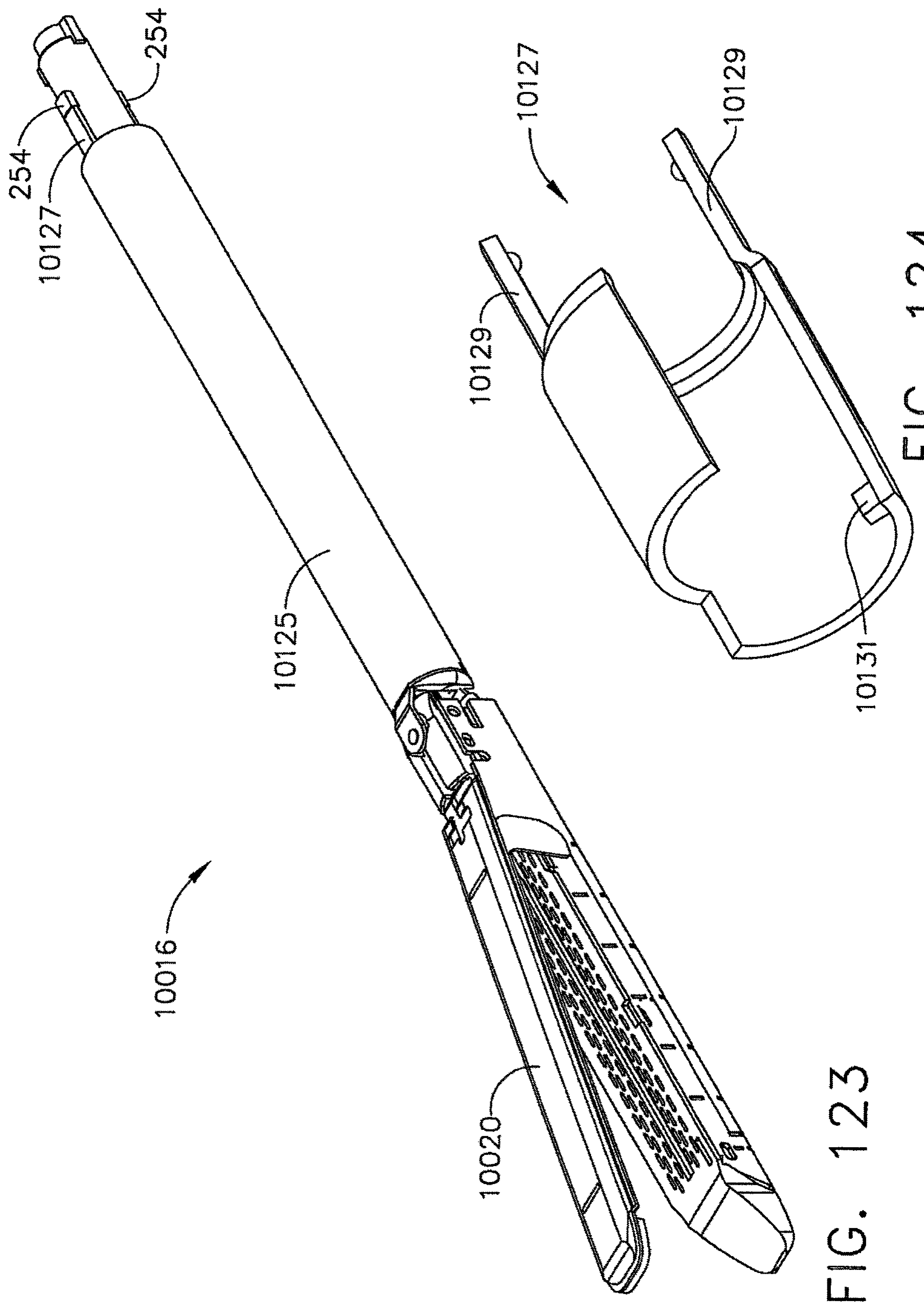


FIG. 123

FIG. 124

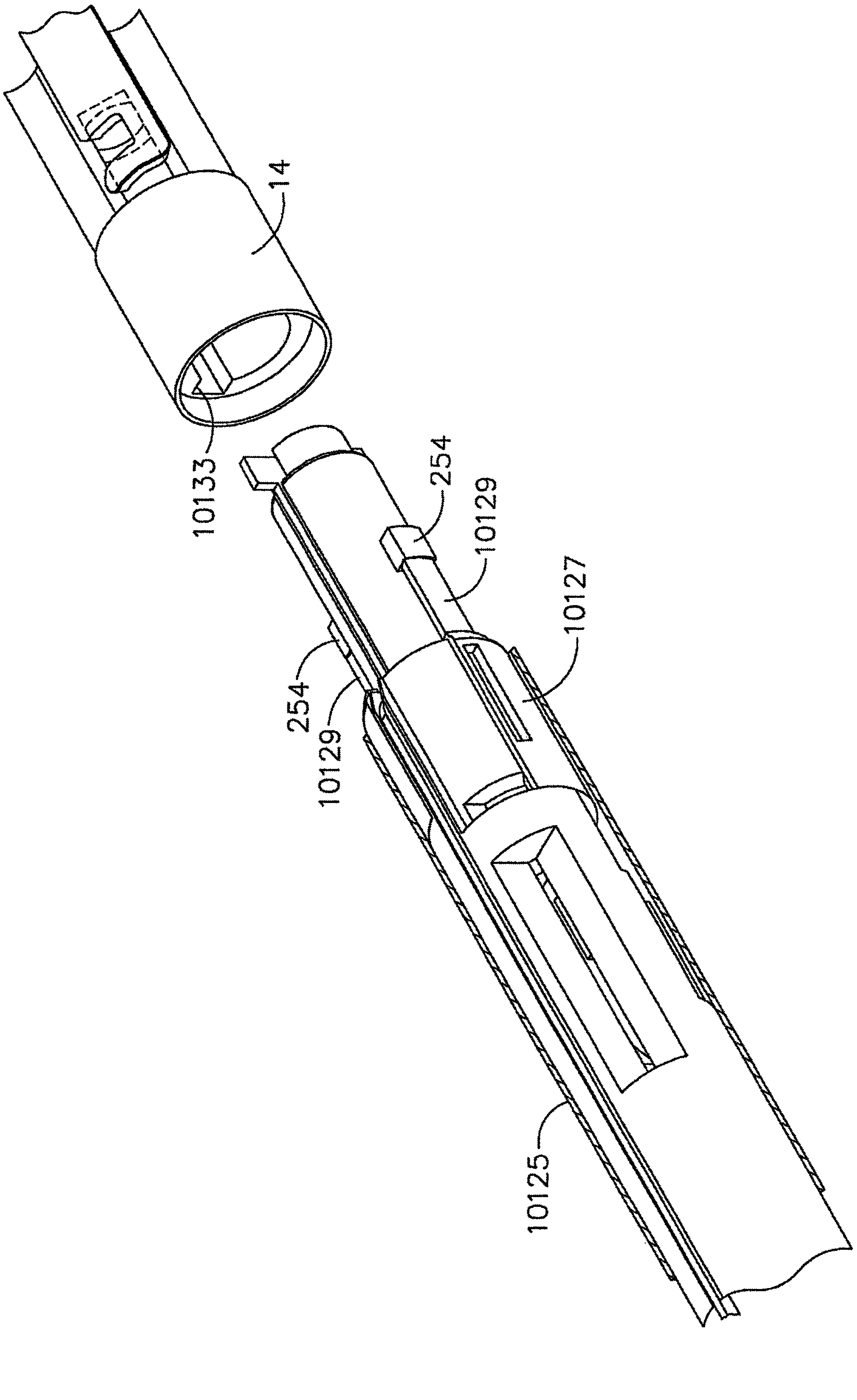


FIG. 125

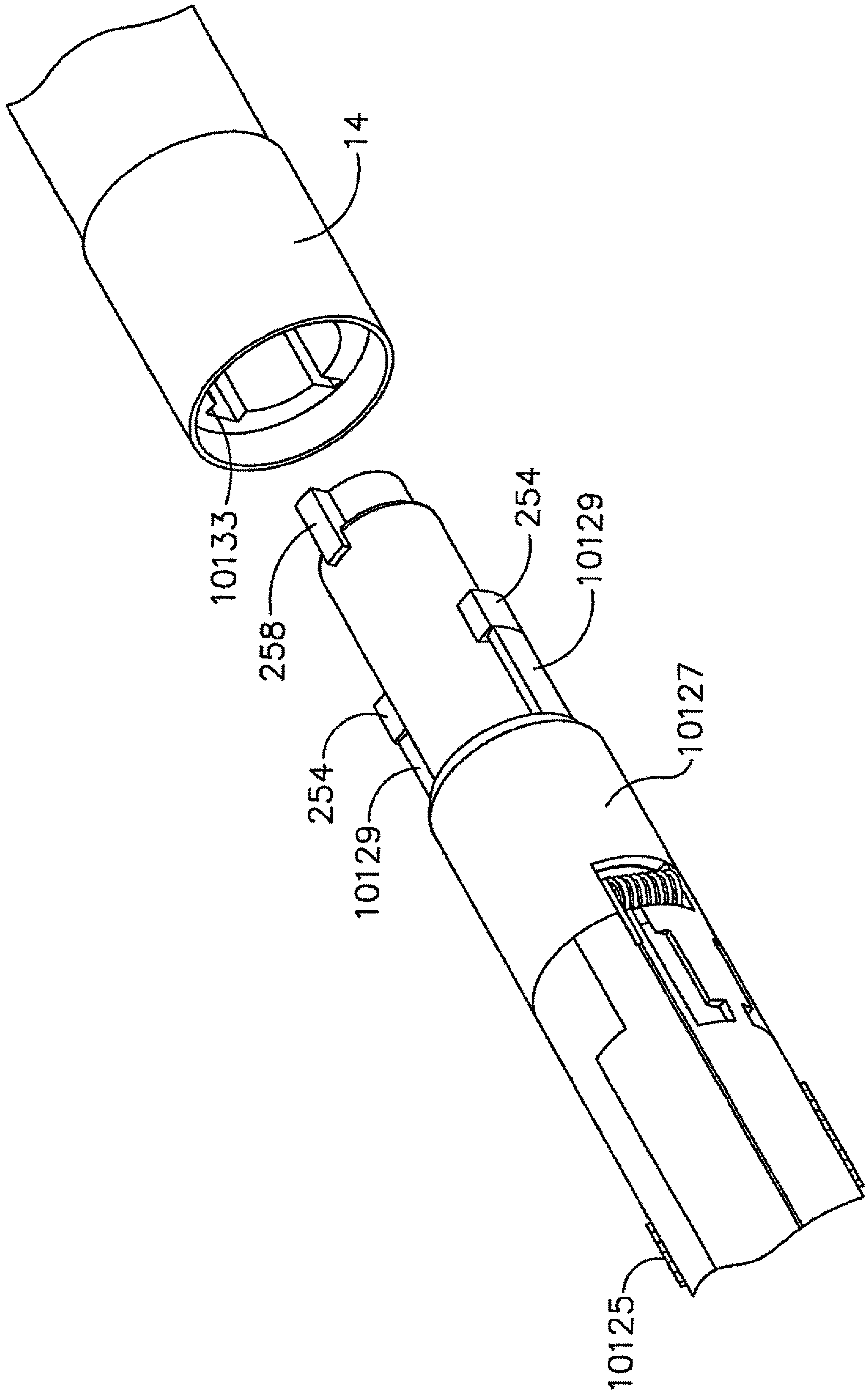


FIG. 126

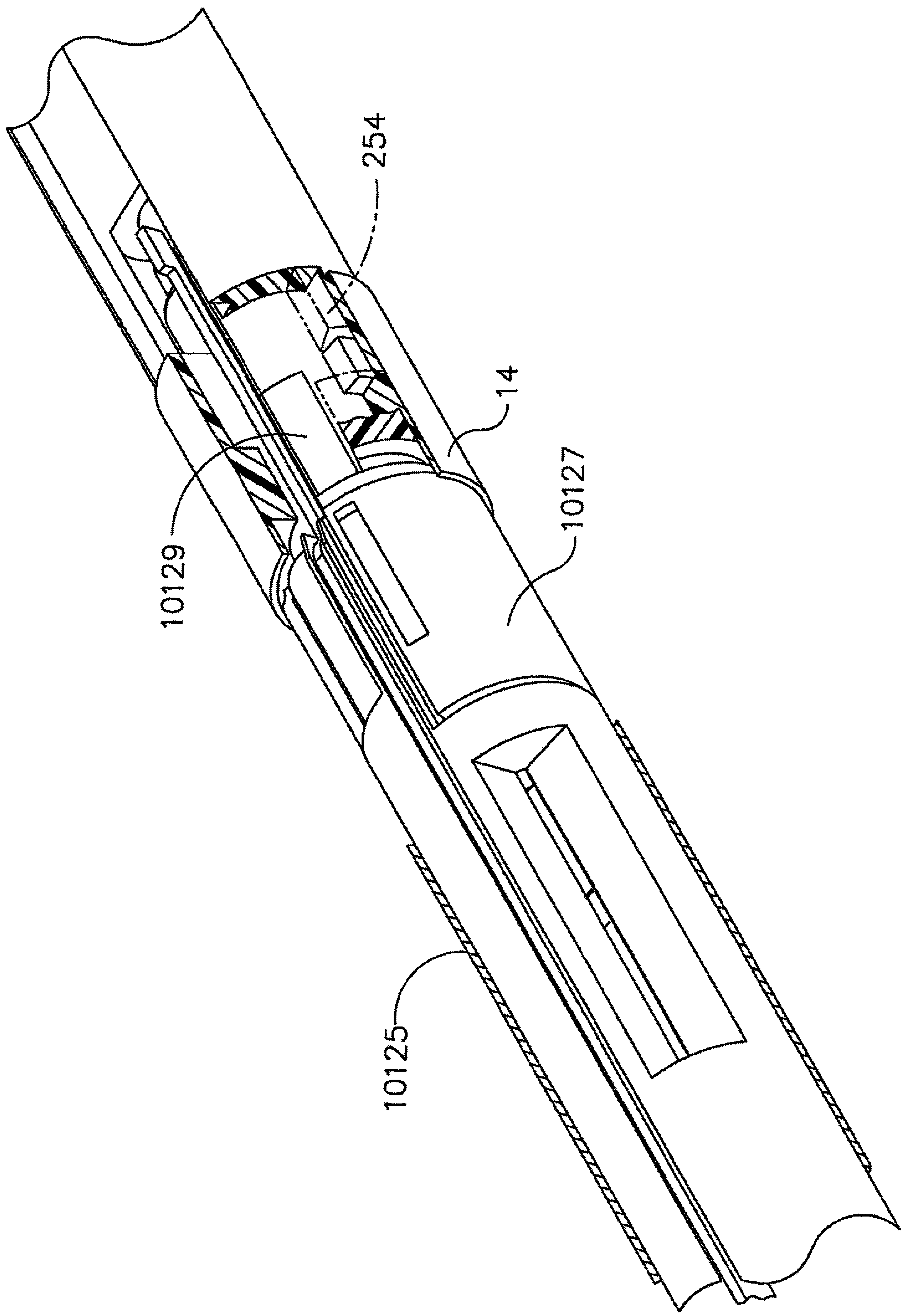


FIG. 127

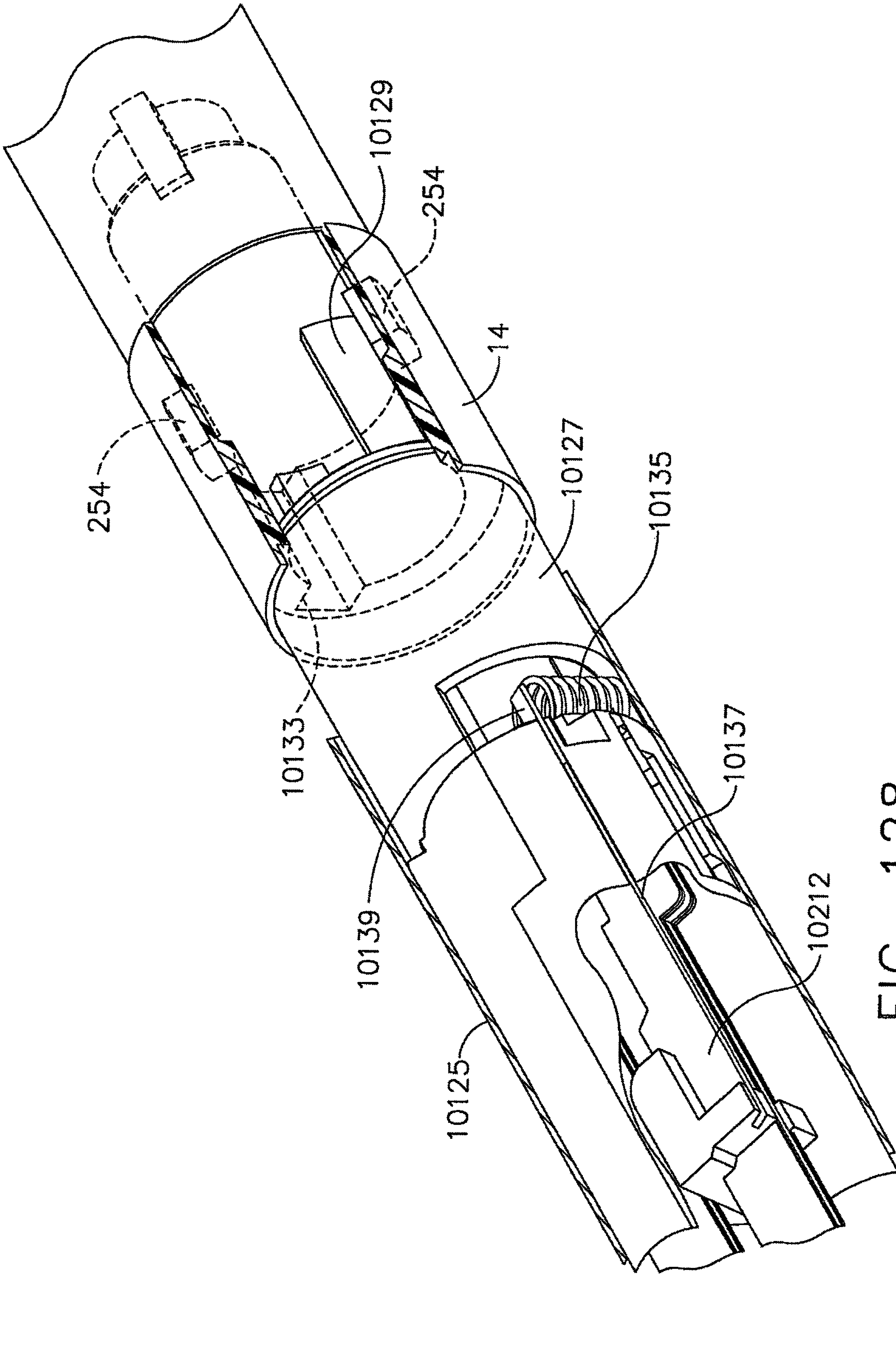


FIG. 128

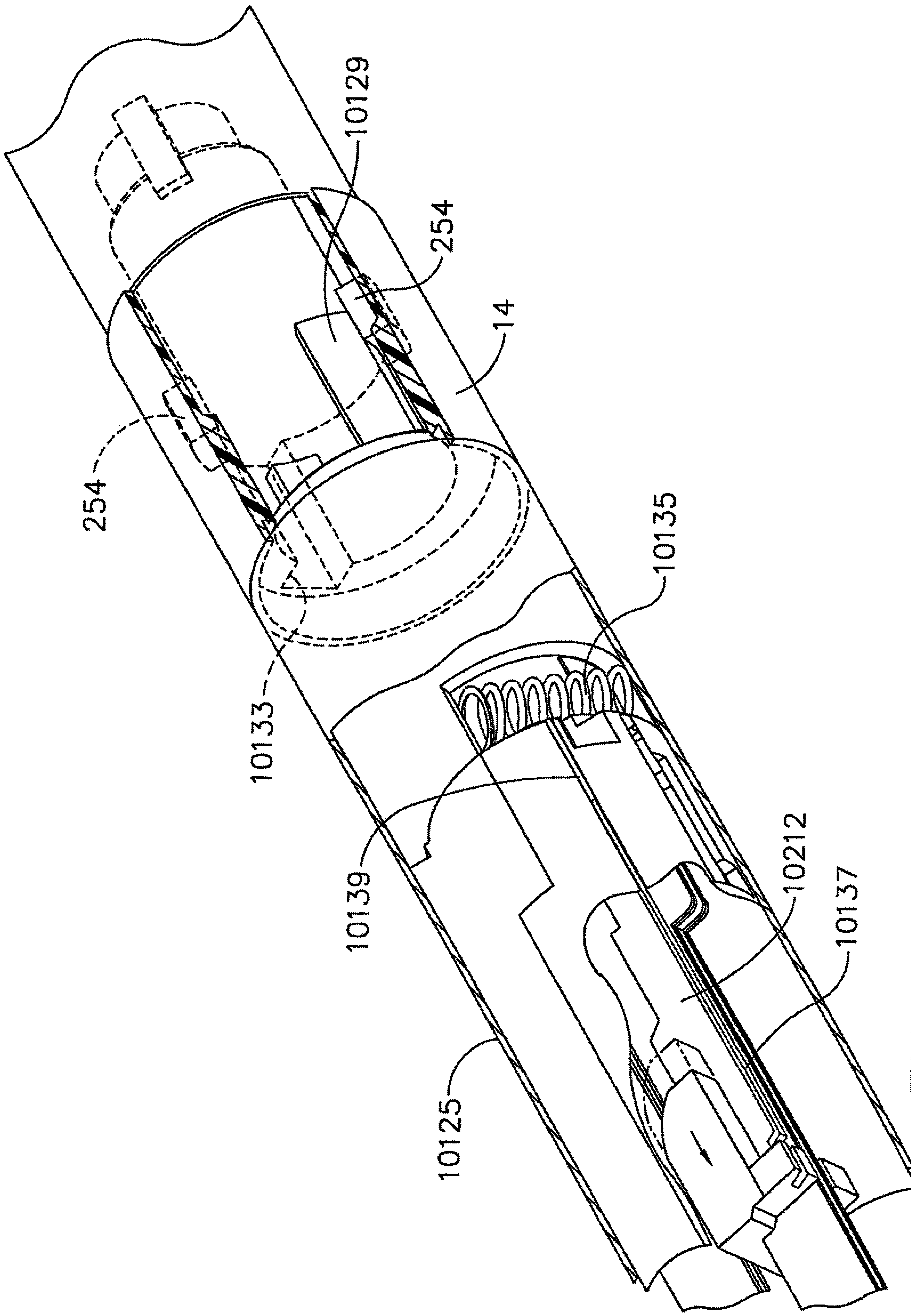


FIG. 129

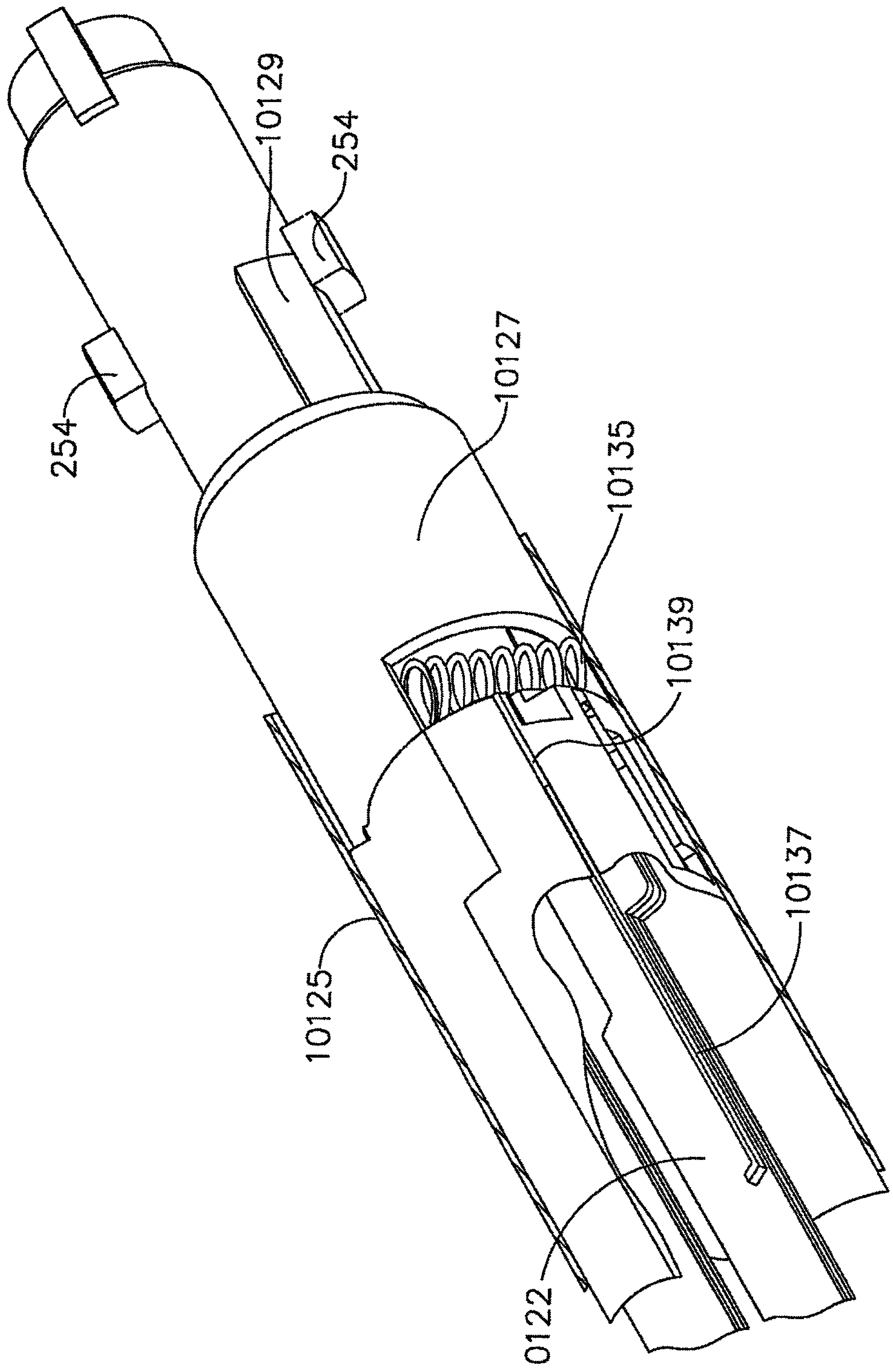


FIG. 130

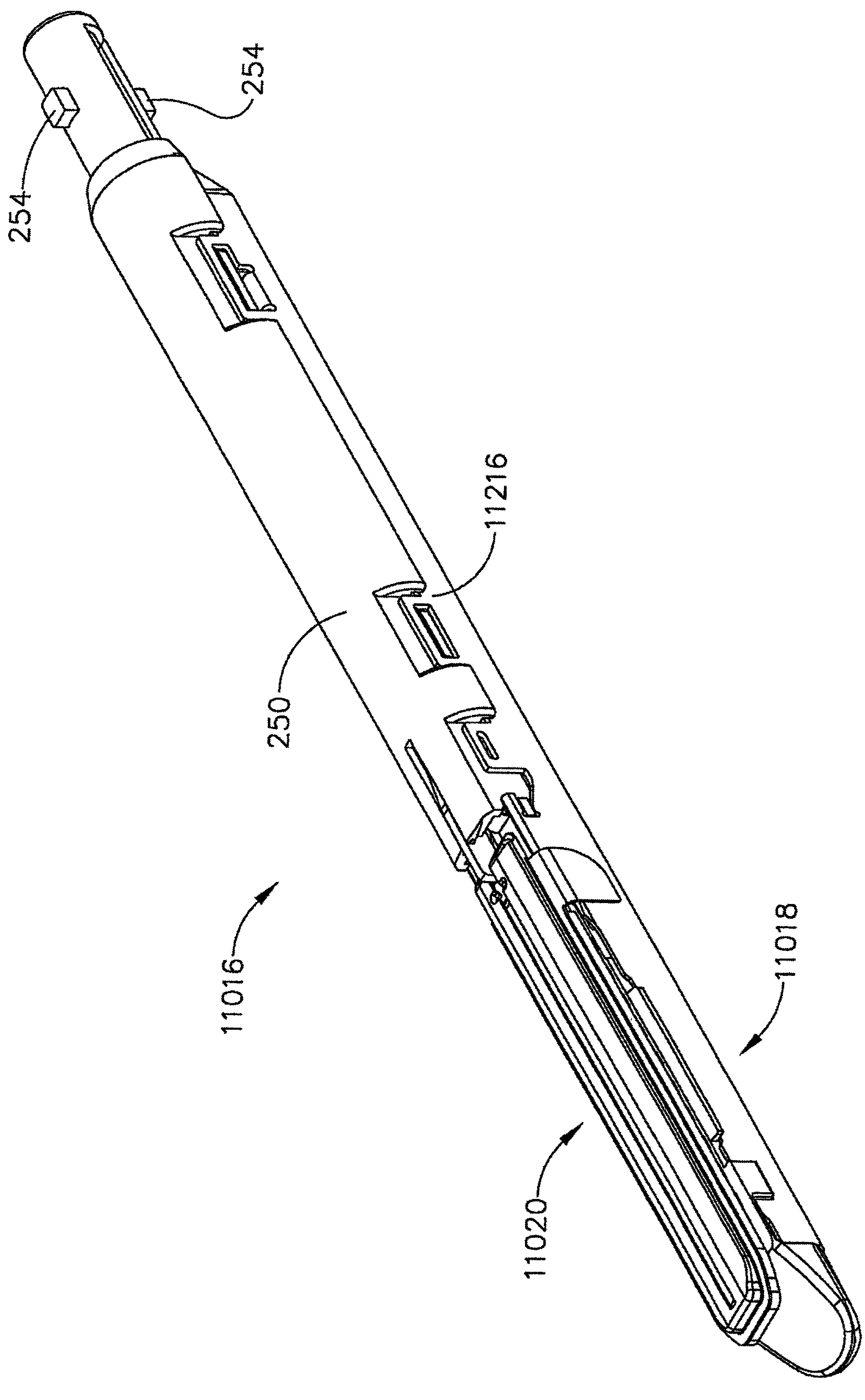


FIG. 131

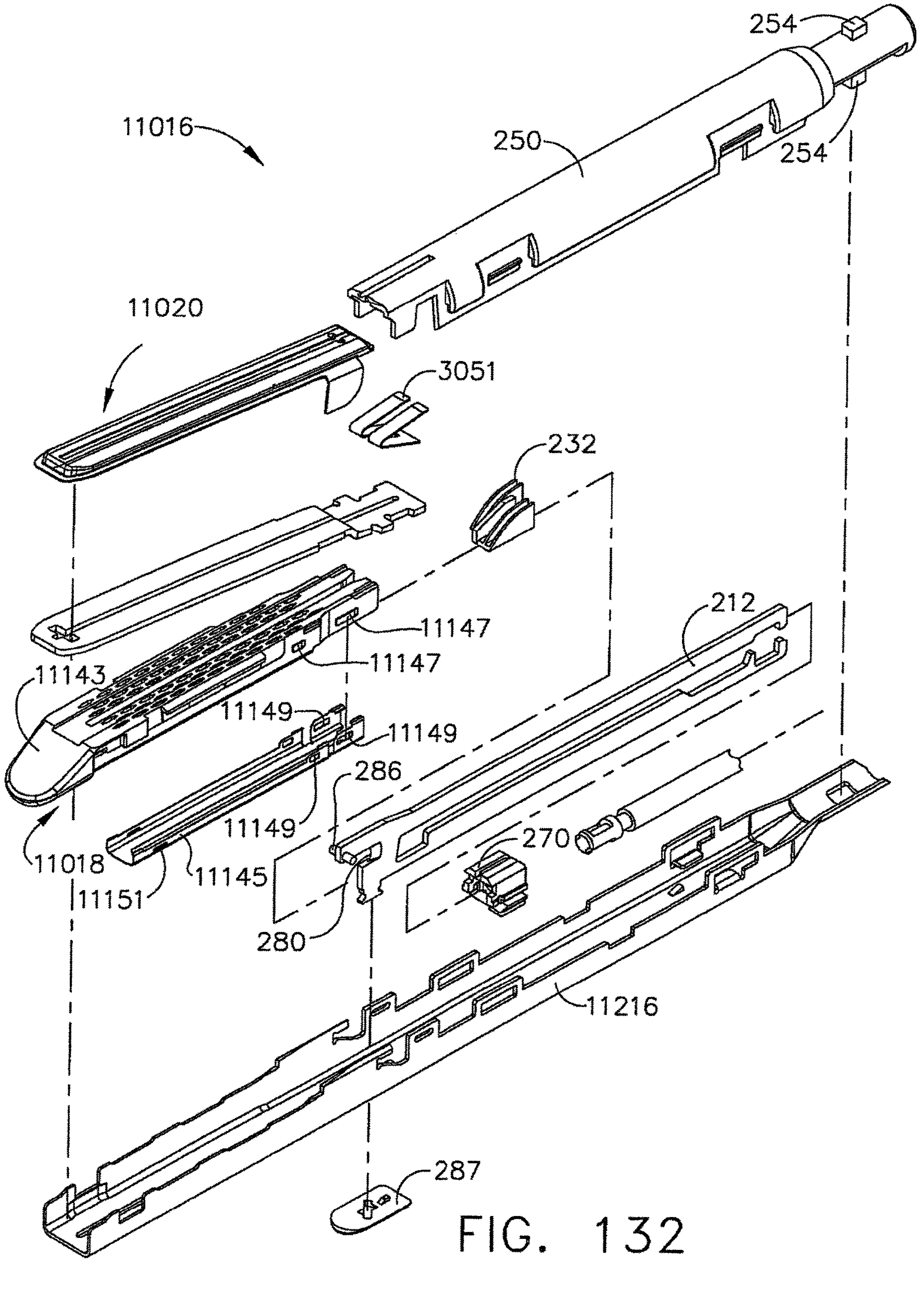

11016
250
254
254
11020
3051
232
212
11147
11147
11143
11149
11149
11149
286
270
11018
11145
11151
280
11216
287

FIG. 132

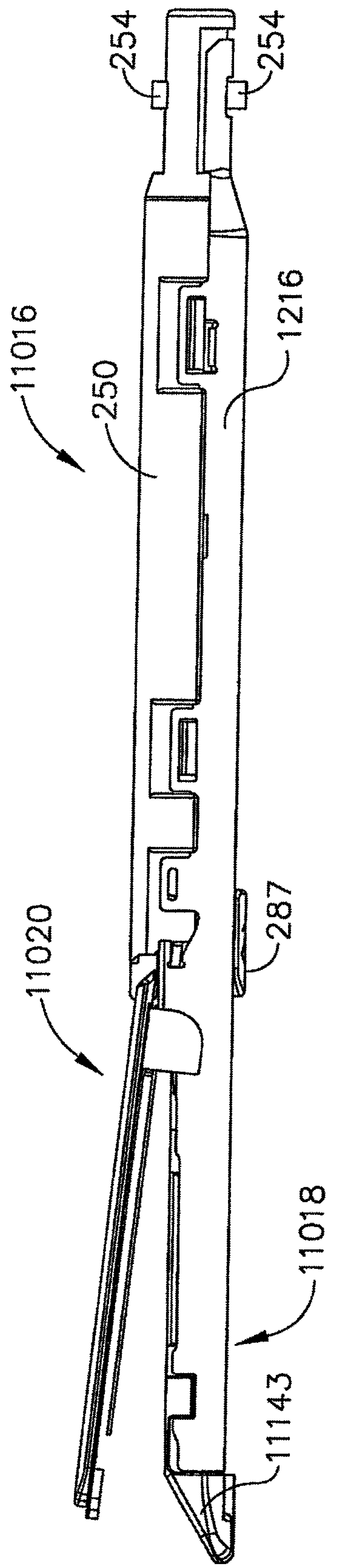


FIG. 133

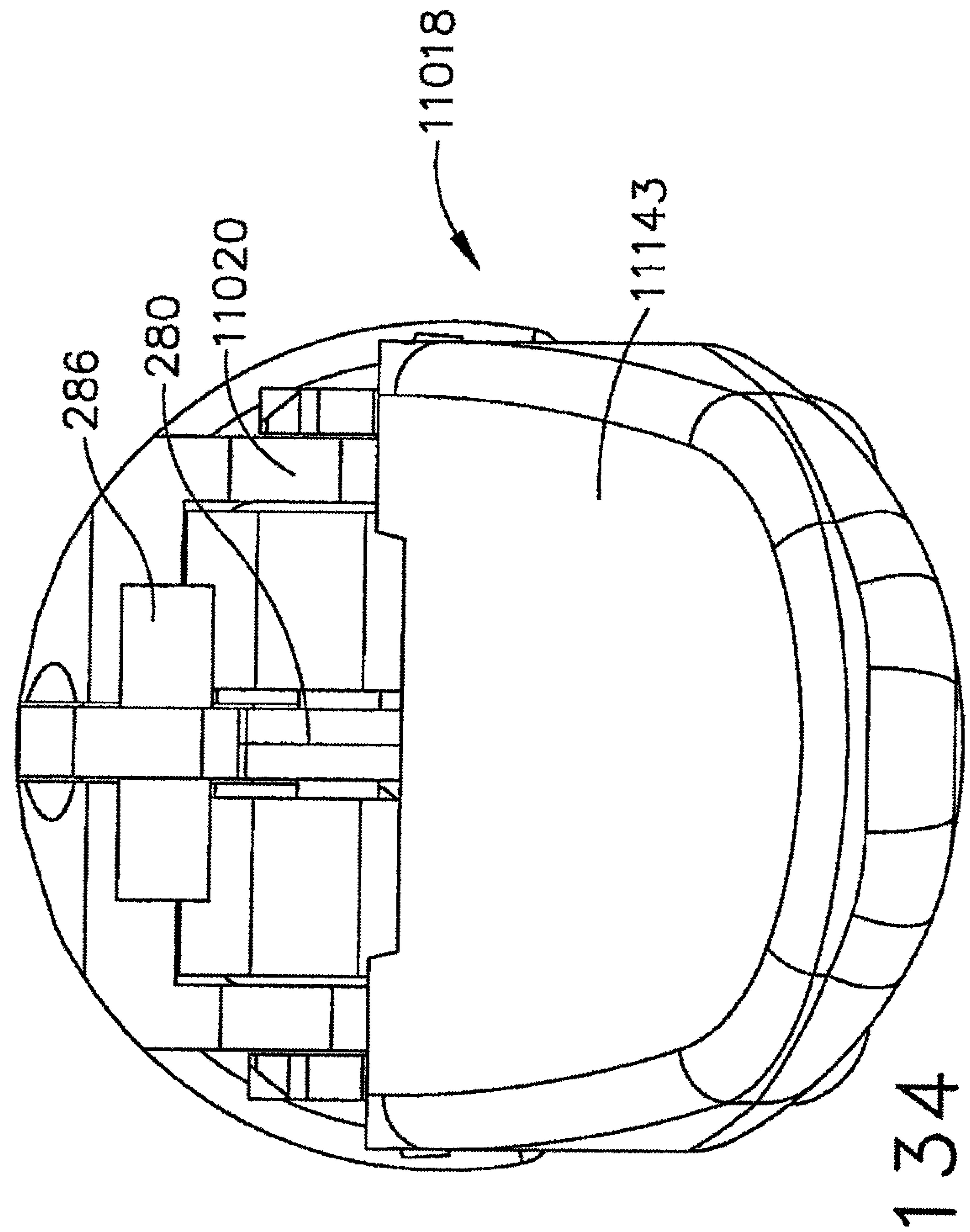


FIG. 134

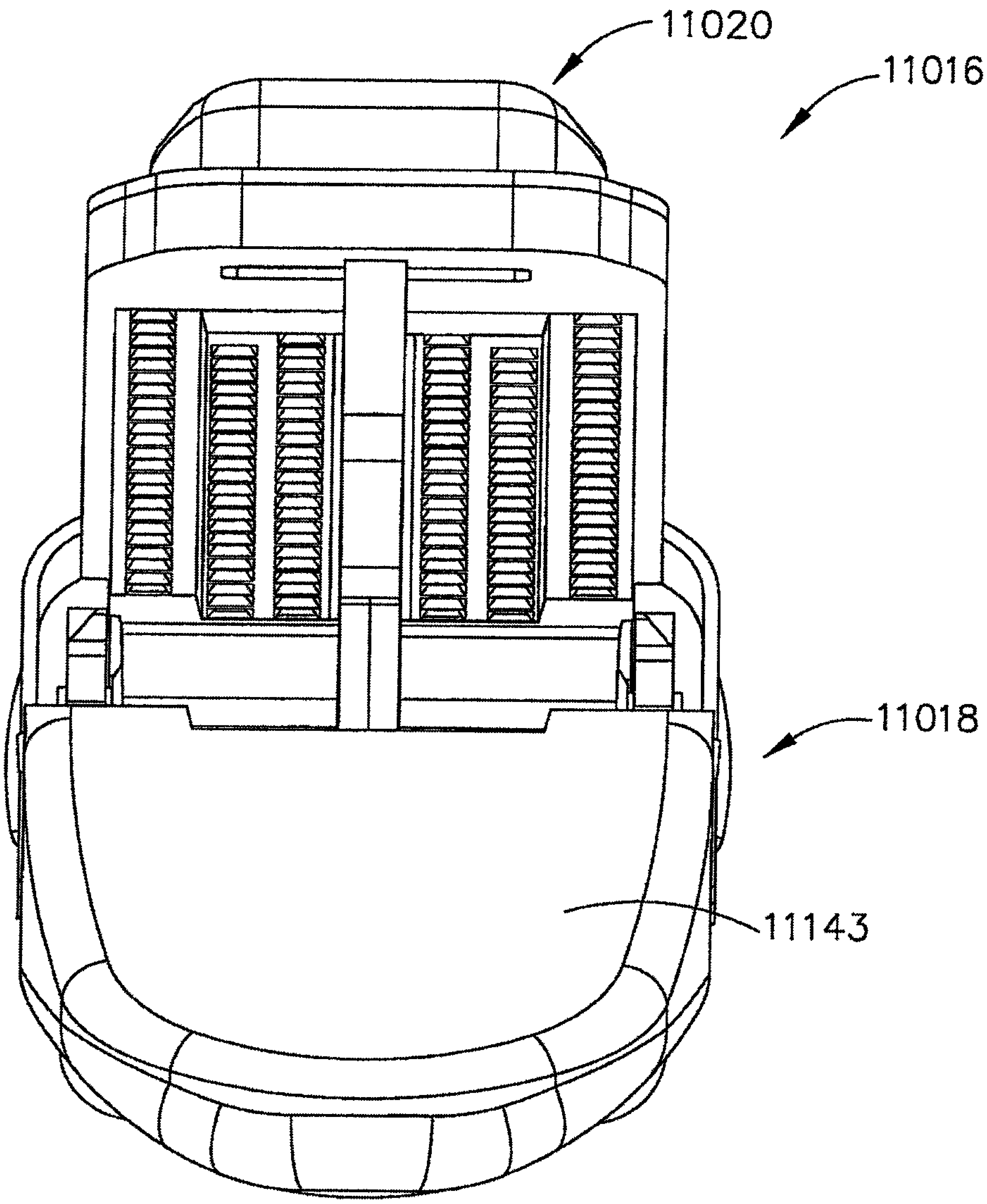


FIG. 135

END EFFECTOR COUPLING ARRANGEMENTS FOR A SURGICAL CUTTING AND STAPLING INSTRUMENT

CROSS-REFERENCE TO RELATED APPLICATIONS

This patent application is a continuation application claiming priority under 35 U.S.C. § 120 from Ser. No. 14/672,620, entitled DISPOSABLE LOADING UNIT FOR USE WITH A SURGICAL INSTRUMENT, filed Mar. 30, 2015, which issued on Mar. 13, 2018 as U.S. Pat. No. 9,913,647, which is a continuation application claiming priority under 35 U.S.C. § 120 from U.S. patent application Ser. No. 14/528,626, entitled END EFFECTOR COUPLING ARRANGEMENTS FOR A SURGICAL CUTTING AND STAPLING INSTRUMENT, filed Oct. 30, 2014, now U.S. Patent Application Publication No. 2015/0060521, which is a continuation application claiming priority under 35 U.S.C. § 120 from U.S. patent application Ser. No. 13/027,641, entitled END EFFECTOR COUPLING ARRANGEMENTS FOR A SURGICAL CUTTING AND STAPLING INSTRUMENT, filed Feb. 15, 2011, which issued on Nov. 4, 2014 as U.S. Pat. No. 8,875,972, which is a continuation application claiming priority under U.S.C. § 120 from U.S. patent application Ser. No. 12/031,817, entitled END EFFECTOR COUPLING ARRANGEMENTS FOR A SURGICAL CUTTING AND STAPLING INSTRUMENT, filed Feb. 15, 2008, now U.S. Patent Application Publication No. 2009/0206131, the entire disclosures of which are hereby incorporated by reference herein.

BACKGROUND

1. Technical Field

This application relates to a surgical stapling apparatus and, in various embodiments, to an articulating mechanism for use with an endoscopic surgical stapling apparatus for sequentially applying a plurality of surgical fasteners to body tissue and optionally incising fastened tissue.

2. Background of Related Art

Surgical devices wherein tissue is first grasped or clamped between opposing jaw structures and then joined by surgical fasteners are well known in the art. In some instruments, a knife is provided to cut the tissue which has been joined by the fasteners. The fasteners are typically in the form of surgical staples but two part polymeric fasteners can also be utilized.

Instruments for this purpose can include two elongated members which are respectively used to capture or clamp tissue. Typically, one of the members carries a staple cartridge which houses a plurality of staples arranged in at least two lateral rows while the other member has an anvil that defines a surface for forming the staple legs as the staples are driven from the staple cartridge. Generally, the stapling operation is effected by cam bars that travel longitudinally through the staple cartridge, with the cam bars acting upon staple pushers to sequentially eject the staples from the staple cartridge. A knife can travel between the staple rows to longitudinally cut and/or open the stapled tissue between the rows of staples. Such instruments are disclosed, for example, in U.S. Pat. Nos. 3,079,606 and 3,490,675, the entire disclosures of which are hereby incorporated by reference herein.

A later stapler disclosed in U.S. Pat. No. 3,499,591, the entire disclosure of which is hereby incorporated by reference herein, applies a double row of staples on each side of the incision. This is accomplished by providing a disposable loading unit in which a cam member moves through an elongate guide path between two sets of staggered staple carrying grooves. Staple drive members are located within the grooves and are positioned in such a manner so as to be contacted by the longitudinally moving cam member to effect ejection of the staples from the staple cartridge of the disposable loading unit. Other examples of such staplers are disclosed in U.S. Pat. Nos. 4,429,695 and 5,065,929, the entire disclosures of which are hereby incorporated by reference herein.

Each of the instruments described above were designed for use in conventional surgical procedures wherein surgeons have direct manual access to the operative site. However, in endoscopic or laparoscopic procedures, surgery is performed through a small incision or through a narrow cannula inserted through small entrance wounds in the skin. In order to address the specific needs of endoscopic and/or laparoscopic surgical procedures, endoscopic surgical stapling devices have been developed and are disclosed in, for example, U.S. Pat. Nos. 5,040,715; 5,307,976; 5,312,023; 5,318,221; 5,326,013; and 5,332,142, the entire disclosures of which are hereby incorporated by reference herein.

Many current laparoscopic linear stapling devices are configured to operate with disposable loading units and staple cartridges of only one size. For example, individual linear staplers are presently available for applying parallel rows of staples measuring 30 mm, 45 mm and 60 mm in length, for example. Thus, during a normal operation, a surgeon may be required to utilize several different stapling instruments to perform a single laparoscopic surgical procedure. Such practices increase the time, complexity and overall costs associated with laparoscopic surgical procedures. In addition, costs are greater in designing and manufacturing multiple stapler sizes, as opposed to creating a single, multipurpose stapler.

It would be extremely beneficial to provide a surgical device for use during laparoscopic and/or endoscopic surgical procedures that can be employed with several different sized disposable loading units to reduce the overall costs associated with such procedures. It would also be particularly beneficial if the device could perform multiple tasks, using disposable loading units of varying size and of varying purpose, such as, for example, to staple, clip, cut and/or articulate.

SUMMARY

In accordance with the present disclosure, improvements to a surgical stapling apparatus for sequentially applying a plurality of fasteners to body tissue and incising tissue are provided. In various embodiments, a surgical stapling apparatus includes a handle portion, an elongated body, or shaft, and a disposable loading unit, wherein the disposable loading unit is removably attachable to the elongated body. In at least one embodiment, the elongated body can include a connector portion which can be operably engaged with a connector portion of the disposable loading unit such that, when a trigger of the handle portion is actuated, the trigger can advance a driver within the disposable loading unit to deploy staples from the disposable loading unit and/or incise tissue. In previous surgical stapling devices, though, the disposable loading unit can become detached from the elongate body causing the surgical stapling instrument to malfunction or be rendered inoperable.

In various embodiments of the present disclosure, such problems can be ameliorated by utilizing a surgical stapling instrument having a handle, a shaft extending from the handle, wherein the shaft defines an axis, and a disposable loading unit which is assembled to the shaft in a direction which is transverse to the shaft axis. Such a connection between the disposable loading unit and the shaft, in at least one embodiment, can prevent, or at least inhibit, the disposable loading unit from being unintentionally displaced proximally and/or distally relative to the shaft of the surgical instrument. In at least one embodiment, the surgical stapling instrument and/or disposable loading unit can further include a collar configured to threadably engage the shaft and/or a portion of the disposable loading unit. In various embodiments, a disposable loading unit and/or elongated body can include a detent assembly for holding the disposable loading unit in place after it has been assembled to the elongated body.

After a disposable loading unit has been attached to a surgical stapling instrument, the instrument can be positioned relative to the soft tissue of a patient. In various circumstances, a surgical stapling instrument can include an anvil and a staple cartridge, where the anvil can be rotated relative to the staple cartridge to position the anvil and the staple cartridge with respect to the soft tissue. In some surgical stapling instruments, the anvil can be configured to clamp the soft tissue between the anvil and the staple cartridge as staples are discharged from the staple cartridge. In various circumstances, a portion of the soft tissue can flow, or move, out of the distal end of the disposable loading unit and, as a result, the soft tissue may not be properly treated by the surgical stapling instrument.

In various embodiments of the present disclosure, such problems can be ameliorated by utilizing a surgical stapling instrument which can clamp the soft tissue, for example, prior to the staples being deployed from the staple cartridge. In various embodiments, a surgical stapling instrument can include an actuator configured to be retracted relative to the distal end of the disposable loading unit where the actuator can be operably engaged with the anvil to rotate the anvil between an open position and a closed position. In at least one embodiment, the actuator can include a cam, where the cam can include an arcuate profile having an apex, and where the apex can be configured to be in contact with the anvil when the anvil is in a closed position. In at least one such embodiment, the anvil can apply a clamping force to the soft tissue prior to the staples being deployed and prevent, or at least inhibit, the soft tissue from flowing, or 'milking', out of the distal end of the disposable loading unit.

In various embodiments of the present disclosure, a surgical stapling instrument can include a disposable loading unit comprising a staple cartridge, an anvil, and a sleeve, wherein the sleeve can be configured to be slid relative to the staple cartridge and the anvil. In at least one embodiment, the sleeve can include an aperture wherein the sleeve can be slid over at least a portion of the anvil and the staple cartridge to hold the anvil in a closed position. In at least one such embodiment, the sleeve can be slid into position to apply a clamping force to the soft tissue before staples are deployed into the soft tissue. In various embodiments, a surgical stapling instrument can include a tongue configured to be slid relative to a staple cartridge and an anvil, wherein the tongue can be configured to engage the anvil and hold the anvil in a closed position. In at least one embodiment, the tongue can be configured such that it applies a force to the anvil at a distal end of the disposable loading unit so as to prevent, or at least reduce, soft tissue from milking out of the distal end.

After the anvil has been moved into a closed position, a drive beam can be advanced within the disposable loading unit to eject the staples therefrom and/or incise the soft tissue. In various circumstances, the anvil can include a slot defined therein which can be configured to receive at least a portion of the drive beam. In use, the drive beam can apply forces to the anvil which can cause the anvil to elastically and/or plastically deform and, as a result, affect the deployment of the surgical staples into the soft tissue. In various embodiments of the present disclosure, an anvil can include a first member having staple pockets for deforming the staples, a first cover plate secured to the first member, and a second cover plate secured to at least one of the first member and the first cover plate, wherein the first and second cover plates can be configured to support the first member. In at least one embodiment, an anvil can include a first member inserted into a second member, where the second member can be deformed such that the first member can be retained to and support the second member. In other various embodiments, the first member can be press-fit into the second member. In at least one embodiment, as a result of the above, the anvil can be better configured to withstand the forces applied thereto and eliminate, or at least reduce, undesirable deflections within the anvil.

In various circumstances, especially during endoscopic surgical procedures, at least a portion of a surgical stapling instrument is inserted through a cannula, or trocar, into a surgical site. Often, an anvil of a disposable loading unit is moved into its closed position before it is inserted into the trocar and then reopened after it has been inserted therethrough. Some disposable loading units having large anvils and/or staple cartridges may not fit, or easily fit, through the trocar. In various embodiments of the present disclosure, a surgical stapling instrument can include a disposable loading unit having an anvil which can be moved between open, closed, and/or collapsed positions to facilitate the insertion of the disposable loading unit through the trocar. More particularly, in at least one embodiment, an anvil can be moved between a closed position in which the anvil is a first distance away from the staple cartridge, for example, and a collapsed position in which the anvil is closer to the staple cartridge such that the disposable loading unit can be more easily inserted through the trocar.

After the disposable loading unit has been used, or expended, it can be removed from the elongated body of the surgical instrument and a new disposable loading unit can be assembled to the elongated body. Thereafter, the surgical instrument can be reinserted into a surgical site to perform additional steps of a surgical technique. In various circumstances, though, a surgeon, or other clinician, may become confused as to whether a disposable loading unit has been previously expended. In various embodiments of the present disclosure, a disposable loading unit can include a lockout feature which can prevent, or at least inhibit, an expended disposable loading unit from being reassembled to the elongated body of the surgical instrument.

BRIEF DESCRIPTION OF THE DRAWINGS

Various preferred embodiments are described herein with reference to the drawings:

FIG. 1 is a perspective view of one preferred embodiment of the presently disclosed surgical stapling apparatus;

FIG. **2** is a top view of the surgical apparatus shown in FIG. **1**;

FIG. **3** is a side view of the surgical apparatus shown in FIG. **1**;

FIG. **4** is a perspective view with parts separated of the handle assembly of the surgical apparatus shown in FIG. **1**;

FIG. **5** is a cross-sectional view of a portion of the firing lockout mechanism shown in FIG. **4**;

FIG. **6** is a perspective of the slide plate of the anti-reverse clutch mechanism of the surgical apparatus;

FIG. **7** is an enlarged perspective view of the anti-reverse clutch mechanism shown in FIG. **1**;

FIG. **8** is a side cross-sectional view of the surgical stapling apparatus shown in FIG. **1** in the non-actuated position with the disposable loading unit removed;

FIG. **9** is a perspective view with parts separated of the rotation member, the articulation mechanism, and the elongated body of the surgical stapling apparatus shown in FIG. **1**;

FIG. **10** is an enlarged view of the indicated area of detail shown in FIG. **8**;

FIG. **10***a* is a perspective view of the translation member of the articulating mechanism and the proximal end of the elongated body of the surgical stapling apparatus shown in FIG. **1**;

FIG. **10***b* is an enlarged cross-sectional view of the indicated area of detail of FIG. **8**;

FIG. **10***c* is a cross-sectional view along section line **10***c*-**10***c* of FIG. **8**;

FIG. **11** is a perspective view of the cam member of the articulation mechanism of the surgical stapling apparatus shown in FIG. **1**;

FIG. **12** is a top view of the cam member of the articulation mechanism of the surgical stapling apparatus shown in FIG. **1**;

FIG. **12***a* is a perspective view of a non-articulating disposable loading unit usable with the surgical stapling apparatus shown in FIG. **1**;

FIG. **12***b* is a perspective view of the preferred articulating disposable loading unit of the surgical stapling apparatus shown in FIG. **1**;

FIG. **13** is a cross-sectional view taken along section line **13-13** of FIG. **10**;

FIG. **14** is a cross-sectional view taken along section line **14-14** of FIG. **10**;

FIG. **15** is a cross-sectional view taken along section line **15-15** of FIG. **10**;

FIG. **16** is an enlarged view of the indicated area of detail shown in FIG. **8**;

FIG. **17** is a side perspective view of the blocking plate of the surgical stapling apparatus shown in FIG. **1**;

FIG. **18** is a top perspective view of the blocking plate of the surgical stapling apparatus shown in FIG. **1**;

FIG. **19** is a perspective view of a disposable loading unit usable with the surgical stapling apparatus of FIG. **1**;

FIG. **20** is another perspective view of a disposable loading unit usable with the surgical stapling apparatus of FIG. **1**;

FIG. **21** is a perspective view of the tool assembly of the surgical stapling apparatus of FIG. **1** with parts separated;

FIG. **22** is an enlarged perspective view of the distal end of the anvil assembly showing a plurality of staple deforming cavities;

FIG. **23** is an enlarged perspective view of the distal end of the staple cartridge of the surgical stapling apparatus shown in FIG. **1**;

FIG. **24** is a side cross-sectional view taken along section line **24-24** of FIG. **23**;

FIG. **25** is a bottom perspective view of the staple cartridge shown in FIG. **21**;

FIG. **26** is an enlarged perspective view of the actuation sled, the pushers and the fasteners shown in FIG. **21**;

FIG. **27** is an enlarged perspective view with parts separated of the proximal housing portion and mounting assembly of the disposable loading unit shown in FIG. **19**;

FIG. **28** is an enlarged perspective view of the mounting assembly of the disposable loading unit shown in FIG. **19** mounted to a distal end portion of the proximal housing portion;

FIG. **29** is an enlarged perspective view of the proximal housing portion and the mounting assembly of the disposable loading unit shown in FIG. **19** with the upper housing half removed;

FIG. **30** is a perspective view of the proximal housing portion and the mounting assembly of the disposable loading unit shown in FIG. **19** with the upper housing half removed;

FIG. **31** is a perspective view with parts separated of the axial drive assembly;

FIG. **32** is an enlarged perspective view of the axial drive assembly shown in FIG. **31**;

FIG. **33** is an enlarged perspective view of the proximal end of the axial drive assembly shown in FIG. **31** including the locking device;

FIG. **34** is an enlarged perspective view of the distal end of the axial drive assembly shown in FIG. **31**;

FIG. **35** is an enlarged perspective view of the distal end of the elongated body of the stapling apparatus shown in FIG. **1**;

FIG. **36** is an enlarged perspective view of the locking device shown in FIG. **33**;

FIG. **37** is an enlarged perspective view of a lower housing half of the proximal housing portion of the disposable loading unit shown in FIG. **27**;

FIG. **38** is a side cross-sectional view of the disposable loading unit shown in FIG. **20**;

FIG. **39** is an enlarged view of the indicated area of detail shown in FIG. **38**;

FIG. **40** is a perspective view of the surgical stapling apparatus shown in FIG. **1** with the disposable loading unit of FIG. **19** detached from the elongated body;

FIG. **41** is an enlarged perspective view of the disposable loading unit of FIG. **19** during attachment to the elongated body of the surgical stapling apparatus shown in FIG. **1**;

FIG. **42** is another enlarged perspective view of the disposable loading unit of FIG. **19** during attachment to the elongated body of the surgical stapling apparatus shown in FIG. **1**;

FIG. **43** is a cross-sectional view taken along section line **43-43** of FIG. **41**;

FIG. **43**A is a side cross-sectional view of the rotation knob, articulation mechanism, and sensing mechanism during insertion of a disposable loading unit into the elongated body of the surgical stapling apparatus;

FIG. **44** is a cross-sectional view taken along section line **44-44** of FIG. **42**;

FIG. **45** is a side cross-sectional view of the distal end of the disposable loading unit of FIG. **1** with tissue positioned between the anvil and clamp assemblies;

FIG. **46** is a side cross-sectional view of the handle assembly with the movable handle in an actuated position;

FIG. **47** is an enlarged view of the indicated area of detail shown in FIG. **46**;

FIG. **48** is a cross-sectional view of the proximal end of the disposable loading unit of FIG. **19** and the distal end of the elongated body of the surgical stapling apparatus shown in FIG. **1** with the control rod in a partially advanced position;

FIG. **49** is a cross-sectional view of the tool assembly of the surgical stapling apparatus shown in FIG. **1** positioned about tissue in the clamped position;

FIG. **50** is a cross-sectional view of the handle assembly of the stapling apparatus of FIG. **1** during the clamping stroke of the apparatus;

FIG. **51** is a side cross-sectional view of the distal end of the tool assembly of the stapling apparatus shown in FIG. **1** during firing of the apparatus;

FIG. **52** is a side cross-sectional view of the distal end of the tool assembly of the stapling apparatus shown in FIG. **1** after firing of the apparatus;

FIG. **53** is a side cross-sectional view of the handle assembly of the apparatus during retraction of the actuation shaft;

FIG. **54** is a side cross-sectional view of the handle assembly of the stapling apparatus during actuation of the emergency release button;

FIG. **55** is a top view of the articulation mechanism of the surgical stapling apparatus;

FIG. **56** is a side cross-sectional view of the articulation mechanism and rotation member of the surgical stapling apparatus shown in FIG. **1**;

FIG. **57** is a top view of the distal end of the elongated body, the mounting assembly, and the proximal end of the tool assembly during articulation of the stapling apparatus;

FIG. **58** is a perspective view of the surgical stapling apparatus during articulation of the tool assembly;

FIG. **59** is a perspective view of the surgical stapling apparatus during articulation and rotation of the tool assembly;

FIG. **60** is a top view of the distal end of the disposable loading unit immediately prior to articulation;

FIG. **61** is a top view of the distal end of the elongated body, the mounting assembly, and the proximal end of the tool assembly during articulation of the stapling apparatus;

FIG. **62** is a partial cross-sectional view of a portion of the disposable loading unit during retraction of the locking device;

FIG. **63** is a partial cross-sectional view of a portion of the disposable loading unit with the locking device in the locked position;

FIG. **64** is a partial perspective view of an elongated body and a disposable loading unit of an embodiment of a surgical stapling apparatus;

FIG. **65** is a perspective view of an embodiment of a surgical stapling apparatus including an elongated body defining an axis and a disposable loading unit;

FIG. **66** is a perspective view of a connector portion of the disposable loading unit of FIG. **65** and a connector portion of the elongated body of FIG. **65**;

FIG. **67** is another perspective view of the connector portions of FIG. **66** with additional components of the disposable loading unit removed;

FIG. **68** is a cross-sectional perspective view of the connector portions of FIG. **66** assembled together and retained in position by a threaded collar;

FIG. **69** is a cross-sectional elevational view of the connector portions of FIG. **66** and the threaded collar of FIG. **68**;

FIG. **70** is a cross-sectional view of a connector portion of a disposable loading unit assembled to a connector portion of an elongated body of an alternative embodiment of a surgical stapling apparatus;

FIG. **71** is a detail view of the connector portions of FIG. **70**;

FIG. **72** is a cross-sectional view of the surgical stapling apparatus of FIG. **70** taken along line **72-72** in FIG. **71**;

FIG. **73** is a detail view of an actuator of the elongated body of FIG. **70**;

FIG. **74** is a perspective view of a disposable loading unit of an alternative embodiment of a surgical stapling apparatus;

FIG. **75** is an exploded view of the disposable loading unit of FIG. **74**;

FIG. **76** is a cross-sectional view of the disposable loading unit of FIG. **74** including an anvil in an open position;

FIG. **76**A is a detail view of the disposable loading unit of FIG. **74** illustrating an actuator operably engaged with the anvil;

FIG. **77** is a cross-sectional view of the disposable loading unit of FIG. **74** illustrating the anvil in a closed position;

FIG. **77**A is a detail view of the anvil and actuator of the disposable loading unit of FIG. **76**A;

FIG. **78** is a plan view of the disposable loading unit of FIG. **74** with some components removed;

FIG. **79** is a detail view of a portion of the disposable loading unit of FIG. **74**;

FIG. **80** is a bottom plan view of the disposable loading unit of FIG. **74**;

FIG. **81** is a cross-sectional view of a staple cartridge carrier of the disposable loading unit of FIG. **74**;

FIG. **82** is a cross-sectional elevational view of an alternative embodiment of a disposable loading unit with some components removed, the disposable loading unit including an anvil in an open position;

FIG. **83** is a detail view of the disposable loading unit of FIG. **82** including an actuator for closing the anvil;

FIG. **84** is another cross-sectional elevational view of the disposable loading unit of FIG. **82** illustrating the anvil in a closed position;

FIG. **85** is a detail view of the actuator and the anvil of FIG. **83**;

FIG. **86** is a perspective view of an anvil and an actuator of an alternative embodiment of a disposable loading unit;

FIG. **87** is a perspective view of an actuator of a further alternative embodiment of a disposable loading unit;

FIG. **88** is a perspective view of a drive beam of an alternative embodiment of a disposable loading unit;

FIG. **89** is an end view of the drive beam of FIG. **88**;

FIG. **90** is a cross-sectional view of a portion of the drive beam of FIG. **88** positioned within a channel of an anvil;

FIG. **91** is a perspective view of a disposable loading unit of an alternative embodiment of a surgical stapling apparatus;

FIG. **92** is an end view of the disposable loading unit of FIG. **91**;

FIG. **93** is a cross-sectional view of the disposable loading unit of FIG. **91**;

FIG. **94** is a cross-sectional view of an alternative embodiment of a disposable loading unit;

FIG. **95** is a cross-sectional view of a further alternative embodiment of a disposable loading unit;

FIG. **96** is a cross-sectional view of another alternative embodiment of a disposable loading unit;

FIG. **97** is a cross-sectional view of an alternative embodiment of a disposable loading unit;

FIG. **98** is a perspective view of an anvil assembly of an alternative embodiment of a disposable loading unit, the anvil assembly including an outer portion and an insert portion;

FIG. **99** is a perspective view of the insert portion of FIG. **98**;

FIG. **100** is a cross-sectional view of the insert positioned within the outer portion of the anvil assembly of FIG. **98**;

FIG. **101** is a cross-sectional view of the anvil assembly of FIG. **98** illustrating the outer portion after it has been deformed to retain the insert portion therein;

FIG. **102** is a diagram of a piece of tubular stock having removed portions which are illustrated in dash;

FIG. **103** is a cross-sectional view of an anvil formed from the tubular stock of FIG. **102**;

FIG. **104** is a cross-sectional view of an anvil assembly of an alternative embodiment of a disposable loading unit, the anvil assembly including an inner portion press-fit within an outer portion;

FIG. **105** is an end view of the inner portion of FIG. **104**;

FIG. **106** is a cross-sectional view of an anvil assembly of an alternative embodiment of a disposable loading unit, the anvil assembly including a body and a support plate attached thereto;

FIG. **107** is a cross-sectional view of the anvil body of FIG. **106**;

FIG. **108** is a cross-sectional view of the support plate of FIG. **106**;

FIG. **109** is a perspective view of an alternative embodiment of a disposable loading unit including an anvil in a closed position and a sleeve in a retracted position;

FIG. **110** is a perspective view of the disposable loading unit of FIG. **109** illustrating the sleeve in an extended position to support the anvil;

FIG. **111** is a perspective view of an alternative embodiment of a disposable loading unit including an anvil in a closed position and a tongue in a retracted position;

FIG. **112** is a perspective view of the disposable loading unit of FIG. **111** illustrating the tongue in an extended position to support the anvil;

FIG. **113** is a cross-sectional view of the disposable loading unit of FIG. **111**;

FIG. **114** is an exploded view of an alternative embodiment of a disposable loading unit;

FIG. **115** is a cross-sectional view of the disposable loading unit of FIG. **114** illustrating an anvil in an open position;

FIG. **116** is a detail view of the disposable loading unit of FIG. **114**;

FIG. **117** is a cross-sectional view of the disposable loading unit of FIG. **114** illustrating the anvil in a closed position;

FIG. **118** is a detail view of the disposable loading unit of FIG. **116**;

FIG. **119** is a cross-sectional view of the disposable loading unit of FIG. **114** illustrating the anvil in a collapsed position;

FIG. **120** is a detail view of the disposable loading unit of FIG. **114**;

FIG. **121** is a cross-sectional view of the disposable loading unit of FIG. **114** illustrating the anvil in its collapsed position;

FIG. **122** is a cross-sectional view of the disposable loading unit of FIG. **114** illustrating the anvil returned to its closed position;

FIG. **123** is a perspective view of an alternative embodiment of a disposable loading unit;

FIG. **124** is a perspective view of a knife lockout of the disposable loading unit of FIG. **123**;

FIG. **125** is a perspective view of the disposable loading unit of FIG. **123** with some components removed and a connector portion of an elongated body of a surgical stapling apparatus;

FIG. **126** is another perspective view of the disposable loading unit of FIG. **123**;

FIG. **127** is another perspective view of the disposable loading unit of FIG. **123** with some components of the elongated body connector portion removed;

FIG. **128** is a perspective view of the disposable loading unit of FIG. **123** prior to a drive beam of the surgical apparatus being advanced within the disposable loading unit and a retention plate engaged with a biasing spring;

FIG. **129** is a perspective view of the disposable loading unit of FIG. **123** after the drive beam has been advanced the retention plate has been disengaged from the biasing spring;

FIG. **130** is a perspective view of the disposable loading unit of FIG. **123** after it has been disengaged from the connector portion of the elongated body illustrating the knife lockout biased into a locked-out position by the biasing spring;

FIG. **131** is a perspective view of an alternative embodiment of a disposable loading unit;

FIG. **132** is an exploded view of the disposable loading unit of FIG. **131** illustrating a removable staple cartridge;

FIG. **133** is an elevational view of the disposable loading unit of FIG. **131**;

FIG. **134** is an end view of the disposable loading unit of FIG. **131**; and

FIG. **135** is another end view of the disposable loading unit of FIG. **131** illustrating an anvil in an open position.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Preferred embodiments of the presently disclosed endoscopic surgical stapling apparatus will now be described in detail with reference to the drawings, in which like reference numerals designate identical or corresponding elements in each of the several views. Those of ordinary skill in the art will understand that the devices and methods specifically described herein and illustrated in the accompanying drawings are non-limiting exemplary embodiments and that the scope of the various embodiments of the present invention is defined solely by the claims. The features illustrated or described in connection with one exemplary embodiment may be combined with the features of other embodiments. Such modifications and variations are intended to be included within the scope of the present invention.

In the drawings and in the description that follows, the term "proximal", as is traditional, will refer to the end of the stapling apparatus which is closest to the operator, while the term distal will refer to the end of the apparatus which is furthest from the operator.

FIGS. **1-3** illustrate one embodiment of the presently disclosed surgical stapling apparatus shown generally as **10**. Briefly, surgical stapling apparatus **10** includes a handle assembly **12** and an elongated body **14**. A disposable loading unit or DLU **16** is releasably secured to a distal end of elongated body **14**. Disposable loading unit **16** includes a tool assembly **17** having a cartridge assembly **18** housing a plurality of surgical staples and an anvil assembly **20** movably secured in relation to cartridge assembly **18**. Disposable loading unit **16** is configured to apply linear rows of staples measuring from about 30 mm to about 60 mm in length.

Disposable loading units having linear rows of staples of other lengths are also envisioned, e.g., 45 mm. Handle assembly **12** includes a stationary handle member **22**, a movable handle member **24**, and a barrel portion **26**. A rotatable member **28** is preferably mounted on the forward end of barrel portion **26** to facilitate rotation of elongated body **14** with respect to handle assembly **12**. An articulation lever **30** is also preferably mounted on the forward end of barrel portion **26** adjacent rotatable knob **28** to facilitate articulation of tool assembly **17**. A pair of retraction knobs **32** are movably positioned along barrel portion **26** to return surgical stapling apparatus **10** to a retracted position, as will be described in detail below.

Referring to FIG. **4**, handle assembly **12** includes housing **36**, which is preferably formed from molded housing half-sections **36***a* and **36***b*, which forms stationary handle member **22** and barrel portion **26** of handle assembly **12** (See FIG. **1**). Movable handle member **24** is pivotably supported between housing half-sections **36***a* and **36***b* about pivot pin **38**. A biasing member **40**, which is preferably a torsion spring, biases movable handle **24** away from stationary handle **22**. An actuation shaft **46** is supported within barrel portion **26** of housing **36** and includes a toothed rack **48**. A driving pawl **42** having a rack engagement finger **43** with laterally extending wings **43***a* and **43***b* is pivotably mounted to one end of movable handle **24** about a pivot pin **44**. A biasing member **50**, which is also preferably a torsion spring, is positioned to urge engagement finger **43** of driving pawl **42** towards toothed rack **48** of actuation shaft **46**. Movable handle **24** is pivotable to move engagement finger **43** of driving pawl **42** into contact with toothed rack **48** of actuation shaft **46** to advance the actuation shaft linearly in the distal direction. The forward end of actuation shaft **46** rotatably receives the proximal end **49** of a control rod **52** such that linear advancement of actuation shaft **46** causes corresponding linear advancement of control rod **52**. A locking pawl **54** having a rack engagement member **55** is pivotably mounted within housing **36** about pivot pin **57** and is biased towards toothed rack **48** by biasing member **56**, which is also preferably a torsion spring. Engagement member **55** of locking pawl **54** is movable into engagement with toothed rack **48** to retain actuation shaft **46** in a longitudinally fixed position.

A retraction mechanism **58** which includes a pair of retractor knobs **32** (See FIG. **1**) is connected to the proximal end of actuation shaft **46** by a coupling rod **60**. Coupling rod **60** includes right and left engagement portions **62***a* and **62***b* for receiving retractor knobs **32** and a central portion **62***c* which is dimensioned and configured to translate within a pair of longitudinal slots **34***a* formed in actuation shaft **46** adjacent the proximal end thereof. A release plate **64** is operatively associated with actuation shaft **46** and is mounted for movement with respect thereto in response to manipulation of retractor knobs **32**. A pair of spaced apart pins **66** extend outwardly from a lateral face of actuation shaft **46** to engage a pair of corresponding angled cam slots **68** formed in release plate **64**. Upon rearward movement of retractor knobs **32**, pins **66** can release plate **64** downwardly with respect to actuation shaft **46** and with respect to toothed rack **48** such that the bottom portion of release plate **64** extends below toothed rack **48** to disengage engagement finger **43** of driving pawl **42** from toothed rack **48**. A transverse slot **70** is formed at the proximal end of release plate **64** to accommodate the central portion **62***c* of coupling rod **60**, and elongated slots **34** (See FIG. **1**) are defined in the barrel section **26** of handle assembly **12** to accommodate the longitudinal translation of coupling rod **60** as retraction knobs **32** are pulled rearwardly to retract actuation shaft **46** and thus retract control rod **52** rearwardly. Actuation shaft **46** is biased proximally by spring **72** which is secured at one end to coupling rod portion **62** via connector **74** and at the other end to post **76** on actuation shaft **46**.

Referring also to FIG. **5**, handle assembly **12** includes a firing lockout assembly **80** which includes a plunger **82** and a pivotable locking member **83**. Plunger **82** is biased to a central position by biasing springs **84** and includes annular tapered camming surfaces **85**. Each end of plunger **82** extends through housing **36** (See FIG. **1**) adjacent an upper end of stationary handle **22**. Pivotable locking member **83** is pivotably attached at its distal end between housing half-sections **36***a* and **36***b* about pivot pin **86** and includes a locking surface **88** and proximal extension **90** having a slot **89** formed therein. Locking member **83** is biased by spring **92** counter-clockwise (as viewed in FIG. **4**) to move locking surface **88** to a position to abut the distal end of actuation shaft **46** to prevent advancement of shaft **46** and subsequent firing of stapling apparatus **10**. Annular tapered camming surface **85** is positioned to extend into tapered slot **89** in proximal extension **90**. Lateral movement of plunger **82** in either direction against the bias of either spring **84** moves tapered camming surface **85** into engagement with the sidewalls of tapered slot **89** to pivot locking member **83** clockwise about pivot pin **86**, as viewed in FIG. **4**, to move blocking surface **88** to a position to permit advancement of actuation shaft **46** and thus firing of stapling apparatus **10**. Blocking surface **88** is retained in this position by recesses **87** which receive the tapered tip of camming surface **85** to lock locking member **83** in a counter-clockwise position. Operation of firing lockout assembly **80** will be further illustrated below.

Referring to FIGS. **4**, **6**, and **7**, handle mechanism **12** also includes an anti-reverse clutch mechanism which includes a first gear **94** rotatably mounted on a first shaft **96**, and second gear **98** mounted on a second shaft **100**, and a slide plate **102** (FIGS. **6** and **7**) slidably mounted within housing **36**. Slide plate **102** includes an elongated slot **104** dimensioned and configured to be slidably positioned about locking pawl pivot pin **57**, a gear plate **106** configured to mesh with the teeth of second gear **98**, and a cam surface **108**. In the retracted position, cam surface **108** of slide plate **102** engages locking pawl **54** to prevent locking pawl **54** from engaging toothed rack **48**. Actuation shaft **46** includes a distal set of gear teeth **110***a* spaced from a proximal set of gear teeth **110***b* positioned to engage first gear **94** of actuation shaft **46** during movement of actuation shaft **46**. When actuation shaft **46** is advanced by pivoting movable handle **24** about pivot pin **38**, distal gear teeth **110***a* on actuation shaft **46** mesh with and rotate first gear **94** and first shaft **96**. First shaft **96** is connected to second shaft **100** by spring clutch assembly such that rotation of first shaft **96** will cause corresponding rotation of second shaft **100**. Rotation of second shaft **100** causes corresponding rotation of second gear **98** which is engaged with gear plate **106** on slide plate **102** to cause linear advancement of slide plate **102**. Linear advancement of slide plate **102** is limited to the length of elongated slot **104**. When slide plate has been advanced the length of slot **104**, cam surface **108** releases locking pawl **54** such that it is moved into engagement with toothed rack **48**. Continued advancement of actuation shaft **46** eventually moves gear teeth **110***b* into engagement with gear plate **106**. However, since slide plate **102** is longitudinally fixed in position, the spring clutch is forced to release, such that continued distal advancement of actuation shaft **46** is permitted.

When actuation shaft **46** is returned to the retracted position (by pulling retraction knobs **34** proximally, as discussed above) gear teeth **110***b* engage first gear **94** to rotate second gear **98** in the reverse direction to retract slide member **102** proximally within housing **36**. Proximal movement of slide member **102** advances cam surface **108** into locking pawl **54** prior to engagement between locking pawl **54** and toothed rack **48** to urge locking pawl **54** to a position to permit retraction of actuation shaft **46**.

Referring again to FIG. **4**, handle assembly **12** includes an emergency return button **112** pivotally mounted within housing **36** about a pivot member **114** supported between housing half-sections **36***a* and **36***b*. Return button **112** includes an externally positioned member **116** positioned on the proximal end of barrel portion **26**. Member **116** is movable about pivot member **114** into engagement with the proximal end of locking pawl **54** to urge rack engagement member **55** out of engagement with toothed rack **48** to permit retraction of actuation shaft **46** during the firing stroke of the stapling apparatus **10**. As discussed above, during the clamping portion of advancement of actuation shaft **46**, slide plate **102** disengages pawl **54** from rack **48** and thus actuation of return button **112** is not necessary to retract the actuation shaft **46**.

FIG. **8** illustrates the interconnection of elongated body **14** and handle assembly **12**. Referring to FIGS. **8-10**, housing **36** includes an annular channel **117** configured to receive an annular rib **118** formed on the proximal end of rotation member **28**, which is preferably formed from molded half-sections **28***a* and **28***b*. Annular channel **117** and rib **118** permit relative rotation between rotation member **28** and housing **36**. Elongated body **14** includes inner housing **122** and an outer casing **124**. Inner housing **122** is dimensioned to be received within outer casing **124** and includes an internal bore **126** (FIG. **8**) which extends therethrough and is dimensioned to slidably receive a first articulation link **123** and control rod **52**. The proximal end of housing **122** and casing **124** each include a pair of diametrically opposed openings **130** and **128**, respectively, which are dimensioned to receive radial projections **132** formed on the distal end of rotation member **28**. Projections **132** and openings **128** and **130** fixedly secure rotation member **28** and elongated body **14** in relation to each other, both longitudinally and rotatably. Rotation of rotation knob **28** with respect to handle assembly **12** thus results in corresponding rotation of elongated body **14** with respect to handle assembly **12**.

An articulation mechanism **120** is supported on rotatable member **28** and includes articulation lever **30**, a cam member **136**, a translation member **138**, and first articulation link **123** (FIG. **9**). Articulation lever **30** is pivotably mounted about pivot member **140** which extends outwardly from rotation member **28** and is preferably formed integrally therewith. A projection **142** extends downwardly from articulation lever **30** for engagement with cam member **136**.

Referring temporarily to FIGS. **11** and **12**, cam member **136** includes a housing **144** having an elongated slot **146** extending through one side thereof and a stepped camming surface **148** formed in the other side thereof. Each step of camming surface **148** corresponds to a particular degree of articulation of stapling apparatus **10**. Although five steps are illustrated, fewer or more steps may be provided. Elongated slot **146** is configured to receive projection **142** formed on articulation lever **30**. Housing **144** includes a distal stepped portion **150** and a proximal stepped portion **152**. Proximal stepped portion **152** includes a recess **154**.

Referring again to FIGS. **8-10** and also to FIGS. **13-15**, translation member **138** includes a plurality of ridges **156** which are configured to be slidably received within grooves **158** formed along the inner walls of rotation member **28**. Engagement between ridges **156** and grooves **158** prevent relative rotation of rotation member **28** and translation member **138** while permitting relative linear movement. The distal end of translation member **138** includes arm **160** which includes an opening **162** configured to receive a finger **164** extending from the proximal end of articulation link **123** (See FIG. **10***a*). A pin **166** having a housing **168** constructed from a non-abrasive material, e.g., Teflon, is secured to translation member **138** and dimensioned to be received within stepped camming surface **148**.

In an assembled condition, proximal and distal stepped portions **150** and **152** of cam member **136** are positioned beneath flanges **170** and **172** formed on rotation member **28** to restrict cam member **136** to transverse movement with respect to the longitudinal axis of stapling apparatus **10**. When articulation lever **30** is pivoted about pivot member **140**, cam member **136** is moved transversely on rotation member **28** to move stepped camming surface **148** transversely relative to pin **166**, forcing pin **166** to move proximally or distally along stepped cam surface **148**. Since pin **166** is fixedly attached to translation member **138**, translation member **138** is moved proximally or distally to effect corresponding proximal or distal movement of first actuation link **123**.

Referring to FIGS. **8-10** and **16**, a disposable loading unit sensing mechanism extends within stapling apparatus **10** from elongated body **14** into handle assembly **12**. The sensing mechanism includes a sensor tube **176** which is slidably supported within bore **26** of elongated body **14**. The distal end of sensor tube **176** is positioned towards the distal end of elongated body **14** and the proximal end of sensor tube **176** is secured within the distal end of a sensor cylinder **176** via a pair of nubs **180**. The distal end of a sensor link **182** is secured to the proximal end of sensor cylinder **178**. Sensor link **182** (See FIGS. **8***a* and **8***c*) has a bulbous end **184** which engages a camming surface **83***a* on pivotable locking member **83**. When a disposable loading unit (not shown) is inserted in the distal end of elongated body **14**, the disposable loading unit engages the distal end **177** of sensor tube **176** to drive sensor tube **176** proximally, and thereby drive sensor cylinder **178** and sensor link **182** proximally. Movement of sensor link **182** proximally causes bulbous end **184** of sensor link **182** to move distally of camming surface **83***a* to allow locking member **83** to pivot under the bias of spring **92** from a position permitting firing of stapling apparatus **10** to a blocking position, wherein blocking member **83** is positioned to engage actuation shaft **46** and prevent firing of stapling apparatus **10**. Sensor link **182** and locking member **83** function to prevent firing of surgical stapling apparatus **10** after a disposable loading unit has been secured to elongated body **14**, without first operating firing lockout assembly **80**. It is noted that movement of link **182** proximally permits locking member **83** to move to its position shown in FIG. **5**.

Referring again to FIGS. **9-12**, cam member **136** includes recess **154**. A locking ring **184** having a nub portion **186** configured to be received within recess **154** is positioned about sensor cylinder **178** between a control tab portion **188** and a proximal flange portion **190**. A spring **192** positioned between flange portion **190** and locking ring **184** urges locking ring distally about sensor cylinder **178**. When an articulating disposable loading unit **16***b* having an extended insertion tip **193** is inserted into the distal end of elongated body **14** of stapling apparatus **10**, insertion tip **193** causes tab portion **188** to move proximally into engagement with locking ring **184** to urge locking ring **184** and nub **186** proximally of recess **154** in cam member **136** (See FIG. **12***b*). With nub **186** positioned proximally of recess **154**, cam member **136** is free to move transversely to effect articulation of stapling apparatus **10**. A non-articulating disposable loading unit does not have an extended insertion tip (See FIG. **12***a*). As such, when a non-articulating disposable loading unit is inserted in elongated body **14**, sensor cylinder **178** is not retracted proximally a sufficient distance to move nub **186** from recess **154**. Thus, cam member **136** is prevented from moving transversely by nub **186** of locking ring **184** which is positioned in recess **154** and articulation lever **30** is locked in its central position.

Referring to FIGS. **16-18**, the distal end of elongated body **14** includes a control rod locking mechanism **190** which is activated during insertion of a disposable loading unit into elongated body **14**. Control rod locking mechanism **190** includes a blocking plate **192** which is biased distally by a spring **194** and includes a proximal finger **189** having angled cam surface **195**. A semi-circular engagement member **196** is biased transversely towards control rod **52** by a spring **197**. Control rod **52** includes an annular recess **199** configured to receive engagement member **196**. Blocking plate **192** is movable from a distal position spaced from engagement member **196** to a proximal position located behind engagement member **196**. In the proximal position, engagement member **196** is prevented from being biased from recess **199** by engagement with blocking plate **192**. During insertion of a disposable loading unit **16** (See FIG. **1**) into the distal end of elongated body **14**, as will be described in further detail below, cam surface **195** of blocking plate **192** is engaged by a nub **254** (FIG. **30**) on the disposable loading unit **16** as the disposable loading unit is rotated into engagement with elongated body **14** to urge plate **192** to the proximal position. Engagement member **196**, which is positioned within recess **199**, is retained therein by blocking plate **192** while nub **254** engages cam surface **195** to prevent longitudinal movement of control rod **52** during assembly. When the disposable loading unit **16** is properly positioned with respect to the elongated body **14**, nub **254** on the proximal end of the disposable loading unit **16** passes off cam surface **195** allowing spring **194** to return blocking plate **192** to its distal position to permit subsequent longitudinal movement of control rod **52**. It is noted that when the disposable loading unit nub passes off cam surface **195**, an audible clicking sound is produced indicating that the disposable loading unit **16** is properly fastened to the elongated body **14**.

Referring to FIGS. **19** and **20**, disposable loading unit **16** includes a proximal housing portion **200** adapted to releasably engage the distal end of body portion **14** (FIG. **1**). A mounting assembly **202** is pivotally secured to the distal end of housing portion **200**, and is configured to receive the proximal end of tool assembly **17** such that pivotal movement of mounting assembly **202** about an axis perpendicular to the longitudinal axis of housing portion **200** effects articulation of tool assembly **17**.

Referring to FIGS. **21-26**, tool assembly **17** preferably includes anvil assembly **20** and cartridge assembly **18**. Anvil assembly **20** includes anvil portion **204** having a plurality of staple deforming concavities **206** (FIG. **22**) and a cover plate **208** secured to a top surface of anvil portion **204** to define a cavity **210** (FIG. **24**) therebetween. Cover plate **208** is provided to prevent pinching of tissue during clamping and firing of stapling apparatus **10**. Cavity **210** is dimensioned to receive a distal end of an axial drive assembly **212** (See FIG. **27**). A longitudinal slot **214** extends through anvil portion **204** to facilitate passage of retention flange **284** of axial drive assembly **212** into the anvil cavity **210**. A camming surface **209** formed on anvil portion **204** is positioned to engage axial drive assembly **212** to facilitate clamping of tissue **198**. A pair of pivot members **211** formed on anvil portion **204** are positioned within slots **213** formed in carrier **216** to guide the anvil portion between the open and clamped positions. A pair of stabilizing members **215** engage a respective shoulder **217** formed on carrier **216** to prevent anvil portion **204** from sliding axially relative to staple cartridge **220** as camming surface **209** is deformed.

Cartridge assembly **18** includes a carrier **216** which defines an elongated support channel **218**. Elongated support channel **218** is dimensioned and configured to receive a staple cartridge **220**. Corresponding tabs **222** and slots **224** formed along staple cartridge **220** and elongated support channel **218** function to retain staple cartridge **220** within support channel **218**. A pair of support struts **223** formed on staple cartridge **220** are positioned to rest on side walls of carrier **216** to further stabilize staple cartridge **220** within support channel **218**.

Staple cartridge **220** includes retention slots **225** for receiving a plurality of fasteners **226** and pushers **228**. A plurality of spaced apart longitudinal slots **230** extend through staple cartridge **220** to accommodate upstanding cam wedges **232** of actuation sled **234**. A central longitudinal slot **282** extends along the length of staple cartridge **220** to facilitate passage of a knife blade **280**. During operation of surgical stapler **10**, actuation sled **234** translates through longitudinal slots **230** of staple cartridge **220** to advance cam wedges **232** into sequential contact with pushers **228**, to cause pushers **228** to translate vertically within slots **224** and urge fasteners **226** from slots **224** into the staple deforming cavities **206** of anvil assembly **20**.

Referring to FIGS. **27** and **28**, mounting assembly **202** includes upper and lower mounting portions **236** and **238**. Each mounting portion includes a threaded bore **240** on each side thereof dimensioned to receive threaded bolts **242** (See FIG. **21**) for securing the proximal end of carrier **216** thereto. A pair of centrally located pivot members **244** (See FIG. **21**) extends between upper and lower mounting portions via a pair of coupling members **246** which engage the distal end of housing portion **200**. Coupling members **246** each include an interlocking proximal portion **248** configured to be received in grooves **250** formed in the proximal end of housing portion **200** to retain mounting assembly **202** and housing portion **200** in a longitudinally fixed position in relation thereto.

Housing portion **200** of disposable loading unit **16** includes an upper housing half **250** and a lower housing half **252** contained within an outer casing **251**. The proximal end of housing half **250** includes engagement nubs **254** for releasably engaging elongated body **14** and an insertion tip **193**. Nubs **254** form a bayonet type coupling with the distal end of body **14** which will be discussed in further detail below. Housing halves **250** and **252** define a channel **253** for slidably receiving axial drive assembly **212**. A second articulation link **256** is dimensioned to be slidably positioned within a slot **258** formed between housing halves **250** and **252**. A pair of blow out plates **254** are positioned adjacent the distal end of housing portion **200** adjacent the distal end of axial drive assembly **212** to prevent outward bulging of drive assembly **212** during articulation of tool assembly **17**.

Referring to FIGS. **29-30**, second articulation link **256** includes at least one elongated metallic plate. Preferably, two or more metallic plates are stacked to form link **256**. The proximal end of articulation link **256** includes a hook portion **258** configured to engage first articulation link **123** (See FIG.

9) and the distal end includes a loop **260** dimensioned to engage a projection **262** formed on mounting assembly **202**. Projection **262** is laterally offset from pivot pin **244** such that linear movement of second articulation link **256** causes mounting assembly **202** to pivot about pivot pins **244** to articulate tool assembly **17**.

Referring also to FIGS. **31-34**, axial drive assembly **212** includes an elongated drive beam **266** including a distal working head **268** and a proximal engagement section **270**. Drive beam **266** may be constructed from a single sheet of material or, preferably, multiple stacked sheets. Engagement section **270** includes a pair of engagement fingers **270***a* and **270***b* which are dimensioned and configured to mountingly engage a pair of corresponding retention slots **272***a* and **272***b* formed in drive member **272**. Drive member **272** includes a proximal porthole **274** configured to receive the distal end **276** of control rod **52** (See FIG. **35**) when the proximal end of disposable loading unit **16** is engaged with elongated body **14** of surgical stapling apparatus **10**.

The distal end of drive beam **266** is defined by a vertical support strut **278** which supports a knife blade **280**, and an abutment surface **283** which engages the central portion of actuation sled **234** during a stapling procedure. Surface **285** at the base of surface **283** is configured to receive a support member **287** slidably positioned along the bottom of the staple cartridge **220**. Knife blade **280** is positioned to translate slightly behind actuation sled **234** through a central longitudinal slot **282** in staple cartridge **220** (FIG. **30**) to form an incision between rows of stapled body tissue. A retention flange **284** projects distally from vertical strut **278** and supports a cylindrical cam roller **286** at its distal end. Cam roller **286** is dimensioned and configured to engage cam surface **209** on anvil body **204** to clamp anvil portion **204** against body tissue.

Referring also to FIGS. **36-39**, a locking device **288** is pivotally secured to drive member **270** about a pivot pin **290**. Locking device **288** includes a pair of elongate glides **292** and **294** which define a channel **296**. A web **298** joins a portion of the upper surfaces of glides **292** and **294**, and is configured and dimensioned to fit within elongated slot **298** formed in drive beam **266** at a position distal of drive member **270**. Horizontal cams **300** and **302** extend from glides **292** and **294** respectively, and are accommodated along an inner surface of lower housing half **252**. As best shown in FIG. **42**, a torsion spring **304** is positioned adjacent drive member **270** and engages horizontal cams **300** and **302** of locking device **288** to normally bias locking device **288** downward toward lower housing half **252** onto ledge **310**. Locking device **288** translates through housing portion **200** with axial drive assembly **212**. Operation of locking device **288** will be described below.

Sequence of Operation

Referring to FIGS. **40-44**, to use stapling instrument **10**, a disposable loading unit **16** is first secured to the distal end of elongated body **14**. As discussed above, stapling instrument **10** can be used with articulating and non-articulating disposable loading units having linear rows of staples between about 30 mm and about 60 mm. To secure disposable loading unit **16** to elongated body **14**, the distal end **276** of control rod **52** is inserted into insertion tip **193** of disposable loading unit **16**, and insertion tip **193** is slid longitudinally into the distal end of elongated body **14** in the direction indicated by arrow "A" in FIG. **41** such that hook portion **258** of second articulation link **256** slides within a channel **310** in elongated body **314**. Nubs **254** will each be aligned in a respective channel (not shown) in elongated body **14**. When hook portion **258** engages the proximal wall **312** of channel **310**, disposable loading unit **16** is rotated in the direction indicated by arrow "B" in FIGS. **41-44** to move hook portion **258** of second articulation link **256** into engagement with finger **164** of first articulation link **123**. Nubs **254** also forms a bayonet type coupling within annular channel **314** in body **14**. During rotation of loading unit **16**, nubs **254** engage cam surface **195** (FIG. **41**) of block plate **192** to initially move plate **192** in the direction indicated by arrow "C" in FIGS. **41** and **43** to lock engagement member **196** in recess **199** of control rod **52** to prevent longitudinal movement of control rod **52** during attachment of disposable loading unit **16**. During the final degree of rotation, nubs **254** disengage from cam surface **195** to allow blocking plate **192** to move in the direction indicated by arrow "D" in FIGS. **42** and **44** from behind engagement member **196** to once again permit longitudinal movement of control rod **52**.

Referring to FIGS. **43** and **43***a*, when insertion tip **193** engages the distal end of sensor tube **176**, the disposable loading unit sensing mechanism is actuated. Insertion tip **193** engages and moves sensor tube **176** proximally in the direction indicated by arrow "E" in FIG. **43**. As discussed above, proximal movement of sensor tube **176** effects proximal movement of sensor cylinder **178** and sensor link **182** in the direction indicated by arrow "E" in FIG. **43***a* to pivot locking member **83** counter-clockwise, as indicated by arrow "Y" in FIG. **43***a*, from a non-blocking position to a position blocking movement of actuation shaft **46**.

Referring to FIGS. **46-49**, with a disposable loading unit attached to stapling instrument **10**, tool assembly **17** can be positioned about tissue **320** (FIG. **45**). To clamp tissue between anvil assembly **20** and cartridge assembly **18**, stationary handle **24** is moved in the direction indicated by arrow "E" in FIG. **46** against the bias of torsion spring **40** to move driving pawl **42** into engagement with shoulder **322** on actuation shaft **46**. Engagement between shoulder **322** and driving pawl **42** advances actuation shaft **46** and thus advances control rod **52** distally. Control rod **52** is connected at its distal end to axial drive assembly **212** (FIG. **48**), including drive beam **266**, such that distal movement of control rod **52** effects distal movement of drive beam **266** in the direction indicated by arrow "F" in FIGS. **48** and **49**, moving cam roller **286** into engagement with cam surface **209** on anvil portion **204** to urge anvil portion **204** in the direction indicated by arrow "G" in FIG. **49**. It is noted that one complete stroke of movable handle **24** advances actuation shaft **46** approximately 15 mm which is sufficient to clamp tissue during the first stroke but not to fire staples.

As discussed above with respect to the anti-reverse clutch mechanism, during the first (clamping) stroke of movable handle **24**, slide plate **102** (FIG. **46**) prevents locking pawl **54** from engaging toothed rack **48**. To maintain actuation shaft **46** in its longitudinal position after handle **24** is released, an engagement member **324** (FIG. **47**) is provided on locking member **83** to engage shoulder **326** on actuation shaft **46** and retain shaft **46** in its longitudinal position (See FIG. **47**). Upon release of movable handle **24**, drive pawl **42** moves over rack **48** as torsion spring **40** returns handle **24** to a position spaced from stationary handle **22**. In this position, driving pawl **42** is urged into engagement with toothed rack **48** to retain actuation shaft **46** in its longitudinal fixed position.

In order to fire staples, movable handle **24** is actuated again, i.e., moved through another stroke. As discussed above, stapling apparatus **10** is capable of receiving disposable loading units having linear rows of staples of between about 30 mm and about 60 mm. Since each stroke of the movable handle **24** preferably advances actuation shaft **46**

15 mm, and one stroke is required to clamp tissue, the movable handle must be actuated (n+1) strokes to fire staples, where n is the length of the linear rows of staples in the disposable loading unit attached to stapling instrument **10** divided by 15 mm.

Referring to FIG. **50**, prior to being able to fire staples, firing lockout assembly **80** (FIG. **4**) must be actuated to move locking surface **88** from its blocking position (FIG. **47**) to a non-blocking position. This is accomplished by pressing down on plunger **82** to move camming surface **85** into engagement with sidewalls of slot **89** of locking member **83** to pivot locking member **83** in the direction indicated by arrow "G" in FIG. **50** (see also FIG. **5**). Thereafter, movable handle **24** may be actuated an appropriate number of strokes to advance actuation shaft **46**, and thus control rod **52** and drive beam **266**, distally in the direction indicated by arrow "H" in FIGS. **51** and **52** to advance actuation sled **234** through staple cartridge **220** to effect ejection of staples. It is noted that after the first or clamping stroke of movable handle **54** (during the second stroke), slide **102** passes over locking pawl **54** allowing torsion spring **56** to move locking pawl **54** in the direction indicated by arrow "I" in FIG. **50** into engagement with toothed rack **48** to retain actuation shaft **46** in its longitudinal position.

Referring to FIG. **53**, to retract actuation shaft **46** and thus control rod **52** and drive member **266** after firing staples, retraction knobs **32** (see FIG. **1**) are pulled proximally causing pins **66** to move release plate **64** in the direction indicated by arrow "J" in FIG. **53** over teeth **48** to disengage drive pawl **42** from engagement with teeth **48**. As discussed above, with respect to the anti-reverse clutch mechanism, locking pawl **54** is urged by slide plate **102** out of engagement with toothed rack **48** (not shown) to permit actuation shaft **46** to be moved proximally, in the direction indicated by arrow "L", after drive pawl **42** is disengaged from teeth **48**.

Referring to FIG. **54**, in order to retract actuation shaft **46** prior to firing stapling apparatus, i.e., when locking pawl is currently engaged with toothed racked **48**, emergency return button **112** is pushed in the direction indicated by arrow "Z" in FIG. **54** to disengage locking pawl **54** from toothed rack **48**. Retraction knobs **32** (FIG. **1**) must also be concurrently pulled rearwardly, as discussed above, to release drive pawl **42** from rack **48**.

Referring to FIGS. **55-61**, when an articulating disposable loading unit is secured to elongated body **14** and articulation lever **30** is pivoted in the direction indicated by arrow "M" in FIG. **55**, cam member **136** is moved transversely by projection **142** (FIG. **10**) in the direction indicated by arrow "N" between flanges **170** and **172** of rotation knob **28**. Since translation member **138** is prevented from rotating by ridges **156** (FIG. **13**), pin **166**, which is fixedly secured to translation member **138**, is forced to move along stepped cam surface **148**. Movement of pin **166** causes corresponding movement of translation member **138** in the direction indicated by arrow "P" in FIGS. **55** and **56** to advance first articulation link **123** in the distal direction. The distal end of first articulation link **123** engages the proximal end of second articulation link **256** (FIG. **42**) which is connected to projection **262** on mounting assembly **202** to advance second link **256** in the direction indicated by arrow "Q" in FIG. **57**. Projection **262** is laterally offset from pivot members **244**, such that distal advancement of second articulation link **256** causes mounting assembly **202** and thus tool assembly **17** to pivot in the direction indicated by arrow "R" in FIGS. **57** and **58**. Note in FIG. **59** that rotation member **28** can be rotated to rotate elongated body **14** about its longitudinal axis while tool assembly **17** is articulated.

FIGS. **60-61** illustrate articulation of tool assembly **17** in the opposite direction to that described above. When second articulation link **256** is retracted by rotating articulation lever **30** in a counter-clockwise direction (not shown) as viewed in FIG. **55**, pin **66** is forced to move proximally along stepped camming surface **148**, moving translation member **138** and first articulation link **123** proximally. Movement of first articulation link **123** proximally, causes second articulation link **256** to move proximally as indicated by arrow "S" in FIG. **58**, to rotate tool assembly **17** in a clockwise direction, as indicated by arrow "T" in FIG. **61**.

Referring to FIG. **12**, movement of pin **166** (FIG. **9**) between adjacent step portions **340** causes tool assembly **17** to articulate 22.5 degrees. Camming surface **148** includes five step portions **340**. The third step portion corresponds to the non-articulated tool assembly position, whereas the first and the fifth step portions correspond to articulation of tool assembly **17** to forty-five degrees. Each step portion is flat to retain articulation lever **30** in a fixed position when pin **166** is engaged therewith.

Referring now to FIGS. **37**, **39**, **62** and **63**, the sequence of lockout operation will be described in detail. In FIG. **39**, lockout device **288** is shown in its prefired position with horizontal cams **300** and **302** resting on top of projections **330** formed in the sidewalls of lower housing half **252** (FIG. **37**). In this position, locking device **288** is held up out of alignment with projection **332** formed in the bottom surface of lower housing half **252**, and web **298** is in longitudinal juxtaposition with shelf **334** defined in drive beam **266**. This configuration permits the anvil **20** (FIG. **38**) to be opened and repositioned onto the tissue to be stapled until the surgeon is satisfied with the position without activating locking device **288** to disable the disposable loading unit **16**.

As shown in FIG. **62**, upon distal movement of drive beam **266**, locking device **288** rides off of projections **330** (not shown) and is biased into engagement with base lower housing half **252** by spring **304**, distal to projection **332**. Locking device **288** remains in this configuration throughout firing of the apparatus.

Upon retraction of the drive beam **266** in the direction indicated by arrow "U" in FIG. **62**, locking device **288** passes under projections **330** and rides over projection **332** until the distalmost portion of locking device **288** is proximal to projection **332**. Spring **304** biases locking device **288** into juxtaposed alignment with projection **332**, effectively disabling the disposable loading unit. If an attempt is made to reactuate the apparatus, the control rod **52** will abut a proximal end surface of locking device **288** which surface is diagonally sloped to impart a moment about pivot pin **342** such that the distal end of locking device **288** is rotationally urged into contact with projection **332**. Continued distal force in the direction indicated by arrow "W" in FIG. **63**, will only serve to increase the moment applied to the locking device thus the locking device will abut projection **332** and inhibit distal movement of the control rod **52**.

Referring again to FIGS. **41-44**, the disabled or locked disposable loading unit can be removed from the distal end of elongated body **14** by rotating disposable loading unit **16** in the direction opposite to the direction indicated by arrow "B" in FIGS. **41**, **42** and **44**, to disengage hook portion **258** of second articulation link **256** from finger **164** of first articulation link **123**, and to disengage nubs **254** from within channel **314** of elongated body **14**. After rotation, disposable loading unit **16** can be slid in the direction opposite to that indicated by arrow "A" in FIG. **41** to detach body **14** from disposable loading unit **16**. Subsequently, additional articulating and/or non-articulating disposable loading units can be secured to the distal end of elongated body, as described above, to perform additional surgical stapling and/or cutting procedures. As discussed above, each disposable loading unit may include linear rows of staples which vary from about 30 mm to about 60 mm.

Although the above-described surgical stapling instruments may be suitable for their intended purpose, improvements to these instruments are provided below. As described above, surgical stapling instruments can include a handle portion, an elongated body, or shaft, and a disposable loading unit, wherein the disposable loading unit can be removably attached to the elongated body. As described above in connection with disposable loading unit **16** illustrated in FIGS. **40-42**, elongated body **14** of the surgical stapling instrument can define an axis along which disposable loading unit **16** can be assembled thereto. In various circumstances, though, disposable loading unit **16** can become unintentionally detached from elongated body **14** causing the surgical stapling instrument to malfunction or be rendered inoperable. Such circumstances can particularly arise when the disposable loading unit becomes detached and separated from the elongated body along the axis defined by the elongated body, i.e., the axis along which the disposable loading unit was assembled to the elongated body. In various embodiments of the present invention, a disposable loading unit can be assembled to an elongated body of a surgical instrument in a direction which is not collinear with or parallel to the elongated body axis. In at least one embodiment, referring to FIG. **65**, disposable loading unit **1016** can be assembled to elongated body **1014** in a direction which is transverse, perpendicular, or oblique to axis **1015** defined by elongated body **1014**.

In various embodiments, referring to FIGS. **66** and **67**, disposable loading unit **1016** can include connector portion **1017** which can be configured to be engaged with connector portion **1019** of elongated body **1014**. In at least one embodiment, connector portion **1017** can include at least one projection and/or groove which can be mated with at least one projection and/or groove of connector portion **1019**. In at least one such embodiment, the connector portions can include co-operating dovetail portions. In various embodiments, the connector portions can be configured to interlock with one another and prevent, or at least inhibit, distal and/or proximal movement of disposable loading unit **1016** along axis **1015**. In at least one embodiment, similar to the devices described above, the surgical stapling instrument can include control rod **1052** which can be operably connected to drive member **1212** of disposable loading unit **1016** such that drive member **1212** can be advanced distally to deploy staples therefrom and/or incise tissue, for example, upon an actuation of handle member **24** (FIG. **1**). In at least one such embodiment, drive member **1212** can include aperture **1272** which can be configured to receive projection **1276** extending from control rod **1052**. In various embodiments, such an arrangement can allow disposable loading unit **1016** to be assembled to elongated member **1014** in a direction which is not collinear with or parallel to axis **1015**. Although not illustrated, drive member **1212** and control rod **1052** can include any other suitable arrangement of projections and apertures to operably connect them to each other. Also similar to the devices described above, the surgical instrument can include first articulation link **1123** which can be operably engaged with second articulation link **1256** such that the operation of articulation lever **1030** can be transmitted to disposable loading unit **1016**.

In various embodiments, further to the above, the projections and/or grooves of connector portions **1017** and **1019** can be configured such that they can be press-fit together to prevent, or at least inhibit, disposable loading unit **1016** from moving in a direction which is transverse to axis **1015**. In at least one embodiment, referring primarily to FIGS. **68** and **69**, a sleeve, or collar, can be utilized to retain the disposable loading unit to the elongated member. In various embodiments, collar **1021** can be threadably engaged with threaded portion **1023** of disposable loading unit **1016** to prevent connector portions **1017** and **1019** from being disengaged from one another. In at least one embodiment, collar **1021** can include aperture **1025** having, first, a threaded portion **1027** which can threadably engage threaded portion **1023** and, second, a second portion **1029** which can closely receive elongated member **1014** so as to prevent, or at least limit, relative movement between disposable loading unit **1016** and elongated member **1014**. Alternatively, although not illustrated, a collar can be configured to threadably engage elongated member **1014** and closely receive disposable loading unit **1016**. In at least one embodiment, a collar can be configured to threadably engage both the elongated member and the disposable loading unit.

In various embodiments, a detent mechanism can be utilized to retain a disposable loading unit to an elongated member of a surgical stapling instrument. In at least one embodiment, referring to FIGS. **70-72**, elongated member **2014** can include at least one ball detent **2031** which can be configured to engage disposable loading unit **2016** and hold disposable loading unit **2016** in position. In various embodiments, elongated member can include at least one aperture **2033** for receiving ball detents **2031** and at least one retention member **2035** for retaining ball detents **2031** in apertures **2033**. In at least one embodiment, retention members **2035** can also be configured to bias ball detents **2031** into recesses **2037** in disposable loading unit **2016** such that the movement of disposable loading unit **2016** along axis **2015** can be prevented, or at least inhibited. In use, insertion tip **2193** of disposable loading unit **2016** can be inserted into elongated member **2014** such that the end of disposable loading unit **2016** can contact ball detents **2031** and displace them radially within apertures **2033**. Once disposable loading unit **2016** has been inserted to its proper depth, recesses **2037** can be substantially aligned with apertures **2033** and retention members **2035** can position at least a portion of ball detents within recesses **2037**.

In various embodiments, further to the above, at least one of retention members **2035** can be comprised of a resilient material. In at least one embodiment, ball detents **2031** and retention members **2035** can be structured and arranged such that retention members **2035** are deflected outwardly by ball detents **2031** and, as a result, resilient members **2035** can apply a biasing force to ball detents **2031**. In order to release disposable loading unit **2016** from elongated member **2014**, elongated member **2016** can further include actuator **2039** which can be manipulated to retract retention members **2035** proximally such that undercut **2041** of resilient members **2035** can be aligned, or at least substantially aligned, with ball detents **2031**. In various embodiments, the alignment of undercut **2041** with ball detents **2031** can allow ball detents **2031** to be displaced radially and out of engagement with recesses **2037** when disposable loading unit **2016** is pulled out of the aperture in elongated member **2014**. In at least one embodiment, referring to FIGS. **70** and **73**, elongated member **2014** can further include return spring **2043** which can be configured to advance actuator **2039** and retention members **2035** distally and reposition retention members **2035** relative to ball detents **2031**. In various embodiments, as illustrated in FIGS. **71** and **72**, ball detents **2031** can be spherical, or at least substantially spherical, and can be comprised of any suitable material such as stainless steel, for example. In other various embodiments, although not illustrated, detents **2031** can have any suitable non-spherical shape.

In various embodiments, a disposable loading unit and an elongated member of a surgical instrument can include co-operating snap-fit features for retaining the disposable loading unit to the surgical stapling instrument. In at least one embodiment, although not illustrated, a disposable loading unit can include arms extending therefrom which can be at least partially received within apertures or recess in an elongated assembly. In use, the arms can be configured to flex inwardly toward each other as they are inserted into the elongated member and then resiliently spring outwardly when the arms are aligned with the apertures. In various embodiments, the surgical instrument can include a lock which can be slid intermediate the arms to hold the arms in the apertures and prevent, or at least inhibit, the disposable loading unit from becoming detached from the surgical instrument. In at least one embodiment, the lock could be slid distally upon an actuation of a trigger. In various alternative embodiments, the lock can include one or more cams configured to engage the arms and retain them in the apertures when the lock is rotated.

After a disposable loading unit has been attached to a surgical stapling instrument, the instrument can be positioned relative to the soft tissue of a patient. In various circumstances, a surgical stapling instrument can include an anvil and a staple cartridge, where the anvil can be rotated relative to the staple cartridge to position the anvil and the staple cartridge with respect to the soft tissue. As described above in connection with disposable loading unit **16** illustrated in FIGS. **38** and **40**, disposable loading unit **16** can include anvil assembly **20** and cartridge assembly **18**, where anvil assembly **20** can be pivoted between an open and closed positions. In some such devices, as outlined above and referring to FIG. **24**, axial drive assembly **212** can be configured to contact camming surface **209** of anvil assembly **20** and move anvil assembly **20** into a closed position upon a first actuation of movable handle **24**. Upon subsequent actuations of movable handle **24**, drive assembly **212** can be advanced through disposable loading unit **16** to clamp, staple, and incise the soft tissue positioned intermediate cartridge assembly **18** and anvil assembly **20**. In such instruments, as a result of the tissue being clamped at the same time as it is being stapled and incised, a portion of the soft tissue can flow, or 'milk', out of the distal end of the disposable loading unit and, in various circumstances, the soft tissue may not be properly treated by the surgical stapling instrument.

In various embodiments of the present invention, such problems can be ameliorated by utilizing a surgical stapling instrument which can apply a clamping force to soft tissue prior to the staples being deployed from the staple cartridge and/or the drive assembly being advanced within the disposable loading unit. In various circumstances, such embodiments can prevent, or at least inhibit, the soft tissue from milking out of the distal end of the disposable loading unit. In at least one embodiment, a surgical stapling instrument can include an actuator configured to be retracted relative to the distal end of the disposable loading unit to rotate the anvil between an open position and a closed position and clamp the tissue in position. In at least one such embodiment, referring to FIGS. **74-81**, disposable loading unit **3016** can include cartridge assembly **3018** and anvil assembly **3020**, where anvil assembly **3020** can be rotated toward cartridge assembly **3018** by actuator **3043**. In at least one embodiment, anvil assembly **3020** can include, first, at least one pivot tab **3211** which can be rotatably received within an aperture or recess within staple cartridge assembly **3018**, for example, and, second, at least one recess **3047** which can be configured to operably receive at least a portion of actuator **3043**. When actuator **3043** is pulled in a direction indicated by arrow "P", in at least one embodiment, actuator **3043** can rotate anvil assembly **3020** into a closed position about an axis defined by pivot tabs **3211** and apply a clamping force to the soft tissue.

In various embodiments, as outlined above, actuator **3043** can include at least one projection **3049** which can be configured to engage the sidewalls of recess **3047** and apply a force to anvil assembly **3020**. In at least one embodiment, such a force can generate a torque, or force-moment, causing anvil assembly **3020** to rotate about pivot tabs **3211** between an open position, as illustrated in FIG. **76**, and a closed position, as illustrated in FIG. **77**. In use, as also outlined above, such a torque can apply a clamping pressure or force to tissue positioned intermediate anvil assembly **3020** and staple cartridge assembly **3018**. In various embodiments, the torque applied to anvil assembly **3020** can be directly proportional to the force applied by actuator **3043** and the distance between projections **3049** and pivot tabs **3211**, i.e., distance "D" (FIG. **77**). In at least one embodiment, a disposable loading unit can be designed such that distance D can be maximized, or at least substantially increased, to apply a larger clamping moment or force to the soft tissue. In at least one such embodiment, referring to FIGS. **80** and **81**, staple cartridge assembly **3018** can comprise staple cartridge carrier **3216** which can include apertures, or recesses, **3045** which can be configured to allow at least a portion of projections **3049** to extend therethrough such that the distance between projections **3049** and pivot tabs **3211** can be increased.

In various embodiments, referring to FIG. **75**, disposable loading unit **3016** can include spring **3051** which can configured to bias anvil assembly **3020** into an open position and, in addition, a spring which can bias actuator **3043** into its most distal position. In use, as outlined above, actuator **3043** can be pulled proximally to pivot anvil assembly **3020** into its closed position. In such circumstances, as illustrated in FIG. **77A**, anvil assembly **3020** can resiliently compress spring **3051** such that spring **3051** can return anvil assembly **3020** to its open position when actuator **3043** is released as described in greater detail below. In various embodiments, a surgical instrument can include a trigger, or any other suitable actuation device, which can be manipulated by a surgeon, or other clinician, to pull actuator **3043** proximally and, in at least one embodiment, lock actuator **3043** in its retracted position. In at least one embodiment, referring generally to FIGS. **1** and **9**, actuator **3043** can be operably engaged with articulation lever **30** and first articulation link **123** such that, when articulation lever **30** is rotated in a first direction, articulation link **123** and actuator **3043** can be retracted proximally. Similarly, when articulation lever **30** is rotated in a second direction, articulation link **123** and actuator **3043** can be advanced distally. In various embodiments, actuator **3043** can be advanced distally to remove projections **3049** from recesses **3047** and allow spring **3051** to return anvil assembly **3020** to its open position.

In various embodiments, a disposable loading unit can include an actuator comprising a cam configured to operably engage an anvil of the disposable loading unit and apply a compressive pressure or force to soft tissue prior to staples being deployed into the soft tissue. In at least one embodiment, referring to FIGS. **82** and **83**, disposable loading unit **4016** can include anvil assembly **4020**, staple cartridge assembly **4018**, and actuator **4043**, where actuator **4043** can be configured to rotate anvil assembly **4020** between an open position, as illustrated in FIG. **82**, and a closed position, as illustrated in FIG. **84**. In various embodiments, referring to FIGS. **82** and **84**, actuator **4043** can include cam **4053** where actuator **4043** can be pulled proximally, i.e., in a direction indicated by arrow "P", such that cam **4053** can engage anvil assembly **4020** and rotate anvil assembly **4020** about an axis defined by pivot tabs **4211**. Similar to the above, actuator **4043** can be operable engaged with any suitable trigger, such as articulation lever **30**, for example, to motivate actuator **4043**.

In various embodiments, an actuator cam can include at least one of a linear, non-linear, arcuate, and/or curvilinear profile. In at least one embodiment, cam **4053** can include an arcuate profile having apex **4055** and initial contact point **4057**, for example, where cam **4053** can be configured to engage anvil assembly **4020** such that initial contact point **4057** first contacts anvil assembly **4020**. As actuator **4043** is pulled further proximally, cam **4053** can slide relative to anvil assembly **4020** such that various other points of cam **4053** contact anvil assembly **4020** until apex **4055** is in contact with anvil assembly **4020** as illustrated in FIG. **85**. At such point, anvil assembly **4020** can be in its closed position. In various embodiments, referring again to FIG. **85**, apex **4055** can be positioned proximally relative to pivot tabs **4211**, i.e., on the proximal side of axis **4059** and, as a result, anvil assembly **4020** can be prevented from rotating back into its open position until cam **4053** is disengaged from, i.e., moved distally relative to, anvil assembly **4020**. Furthermore, the position of apex **4055** relative to pivot tabs **4211** can utilize leverage, or mechanical advantage, to apply an even greater clamping force to the soft tissue.

In various embodiments, as cam **4053** is retracted proximally and anvil assembly **4020** is rotated into its closed position as described above, anvil assembly **4020** can contact soft tissue, for example, positioned intermediate anvil assembly **4020** and staple cartridge assembly **4018**. In at least one embodiment, anvil assembly **4020** can apply an initial clamping force to the soft tissue when it initially contacts the tissue and wherein anvil assembly **4020** can apply an increasingly greater force to the soft tissue as anvil assembly **4020** is moved into its final, or closed, position. In various embodiments, the clamping force can be increased in a substantially linear manner. In at least one embodiment, a cam, such as cam **4053**, for example, can be configured to drive anvil **4020** in such a manner as to increase the clamping force to the soft tissue in a non-linear manner. In at least one such embodiment, the clamping force can be increased in a geometric manner such that the climax of the clamping force is applied to the soft tissue when anvil assembly **4020** is in its final, or closed, position, for example. As a result of the above, an anvil can apply a clamping force to soft tissue prior to staples being deployed from the staple cartridge, for example, and prevent, or at least inhibit, the soft tissue from flowing, or 'milking', out of the distal end of the disposable loading unit.

In various embodiments, further to the above, a cam can include a profile which utilizes a variable mechanical advantage as the anvil is moved into its closed position. In at least one embodiment, the cam can include a compound profile which includes a first portion for utilizing a first mechanical advantage, or leverage, during the initial movement of the anvil and, in addition, a second portion for utilizing a second mechanical advantage, or leverage, for subsequent movement of the anvil. In at least one such embodiment, a larger mechanical advantage can be utilized during the final movement of the anvil so as to apply a larger clamping force to the soft tissue when the anvil is in its closed position.

In various embodiments, referring to FIGS. **84** and **85**, anvil assembly **4020** can include a tissue-contacting surface, such as surface **4063**, for example, which can be positioned parallel to, or at least substantially parallel to, a tissue-contacting surface on staple cartridge assembly **4018**, such as surface **4065**, for example, when anvil assembly **4020** is in its closed position. In at least one embodiment, anvil assembly **4020** and staple cartridge assembly **4018** can be configured such that there is a gap defined between anvil assembly **4020** and staple cartridge assembly **4018** when anvil assembly **4020** is in its closed position. In various embodiments, the distance between tissue-contacting surfaces **4063** and **4065** can be shorter at distal end **4069** of the disposable loading unit as compared to proximal end **4067**. In at least one such embodiment, as a result, the distal end of anvil assembly **4020** can trap soft tissue within the disposable loading unit when anvil assembly **4020** is moved into its closed position. In other various embodiments, the gap between tissue-contacting surfaces **4063** and **4065** can have a consistent, or at least a substantially consistent, distance between proximal end **4067** and distal end **4069**.

In various embodiments, referring to FIG. **86**, an actuator, such as actuator **4043'**, for example, can include two or more cams **4053** which can be configured to engage at least a portion of anvil assembly **4020** as described above. In at least one embodiment, cams **4053** can extend from a shaft portion **4061'** of actuator **4043'** such that cams **4053** can be moved relative to anvil assembly **4020** simultaneously. In various embodiments, actuator **4043'** can also include at least one hook portion **258** configured to engage first articulation link **123** as outlined further above. In various alternative embodiments, referring to FIG. **87**, a disposable loading unit can include two or more actuators, such as actuators **4043"**, for example, which can each include one or more cams **4053**, for example, for pivoting anvil assembly **4020**. In at least one such embodiment, each actuator **4043"** can include a hook portion **258** which can be operably connected with one or more articulation links, for example, in a surgical stapling instrument.

In various embodiments of the present invention, a surgical stapling instrument can include a disposable loading unit comprising a staple cartridge, an anvil, and a sleeve, wherein the sleeve can be configured to be slid relative to the staple cartridge and the anvil and hold at least one of the anvil and the staple cartridge in position. In at least one embodiment, referring to FIGS. **109** and **110**, disposable loading unit **5016** can include at least one sleeve or collar, such as sleeve **5071**, for example, which can be slid between a proximal position, as illustrated in FIG. **109**, and a distal position, as illustrated in FIG. **110**. In at least one embodiment, sleeve **5071** can include an aperture which, when sleeve **5071** is positioned in its distal position, for example, can at least partially encompass or surround anvil assembly **5020** and/or staple cartridge assembly **5018**. In various embodiments, sleeve **5071** can be configured to prevent anvil assembly **5020** from prematurely opening. Furthermore, sleeve **5071** can prevent, or at least inhibit, anvil assembly **5020** and staple cartridge assembly **5018** from deflecting when the soft tissue positioned therebetween is stapled and/or incised.

In at least one embodiment, sleeve **5071**, for example, can be configured to apply a clamping pressure or force to the soft tissue positioned between anvil assembly **5020** and staple cartridge assembly **5018**. In various embodiments, similar to the above, such a clamping pressure or force can be applied before surgical staples are deployed from the staple cartridge and/or the soft tissue is incised. In various embodiments, referring again to FIGS. **109** and **110**, sleeve **5071** can further include slots **5079** which can be configured such that, when sleeve **5071** is advanced distally, sleeve **5071** may not contact and/or damage the tissue positioned between anvil assembly **5020** and staple cartridge assembly **5018**.

In various embodiments, a surgical stapling instrument can include a cantilever, or tongue, configured to be slid relative to at least one of a staple cartridge and an anvil and engage at least one of the staple cartridge and anvil to hold them in a closed position, for example. In at least one embodiment, referring to FIGS. **111** and **112**, disposable loading unit **6016** can include at least one sleeve or collar, such as sleeve **6071**, for example, which can be slid between a proximal position, as illustrated in FIG. **111**, and a distal position, as illustrated in FIG. **112**. In at least one embodiment, sleeve **6071** can include tongue **6073** extending therefrom which can be configured to engage at least a portion of anvil assembly **6020** and apply a force thereto. In various embodiments, such a force can position anvil assembly **6020** against the soft tissue positioned intermediate anvil assembly **6020** and staple cartridge assembly **6018** and clamp the soft tissue therebetween. Referring to FIG. **113**, tongue **6073**, for example, can comprise any suitable configuration including an arcuate, linear, and/or curvi-linear configuration. In at least one embodiment, tongue **6073** can include a curved body comprising proximal end **6075** connected to sleeve **6071** and a distal tip **6077** which can be configured to engage anvil assembly **6020** within anvil cavity **6210**. In at least one such embodiment, the force transmitted between tongue **6073** and anvil assembly **6020** can be applied to anvil assembly **6020** through tip **6077** and, as a result, the location in which the force is applied to the soft tissue can be dictated by the position of tip **6077**.

In various embodiments, sleeve **6071** can be configured such that it can be advanced between its proximal and distal positions prior to staples being deployed from staple cartridge assembly **6018** and the tissue being incised by drive member **6212**, for example. In at least one such embodiment, referring to FIG. **113**, tongue **6073** can be slid distally by sleeve **6071** until distal tip **6077** of tongue **6073** contacts anvil assembly **6020** at distal end **6069**. Thereafter, similar to the above, drive assembly **6212** can be advanced toward the distal end of the disposable loading unit to staple and/or incise the tissue. In such circumstances, the clamping force applied to the soft tissue by tongue **6073** can be applied at the distal end of the disposable loading unit and the possibility that the tissue may milk out of the distal end of the disposable loading unit can be reduced. In other various embodiments, distal tip **6077** can be advanced toward distal end **6069** as drive member **6212** is advanced toward distal end **6069**, for example. In at least one embodiment, distal tip **6077** can be configured to contact anvil assembly **6020** at a location which is positioned directly over, or at least adjacent to, knife blade **6280**. In such embodiments, tongue **6073** can support anvil assembly **6020** directly above the location in which staples are deformed against anvil assembly **6020**.

After an anvil of a disposable loading unit has been moved into a closed position, as outlined above, a drive beam can be advanced within the disposable loading unit to eject the staples therefrom and/or incise soft tissue. In various embodiments, a drive beam, such as drive beam **266**, for example, can be comprised of a single sheet of material and/or multiple stacked sheets of material. As also outlined above, a drive assembly, such as drive assembly **212**, for example, can further comprise a cam roller **286** and a support member **287** which can be configured to retain drive beam to anvil assembly **20** and staple cartridge assembly **18**, respectively. In various circumstances, the time and cost to assemble such components to drive beam **266** can be significant. In various embodiments of the present invention, such time and cost can be reduced. More particularly, in at least one embodiment of the present invention, a portion of a drive beam can be deformed, or otherwise integrally formed, so as to create features which can obviate the need for a separately-manufactured cam roller **286** and/or support member **287**, for example. In various embodiments, referring to FIGS. **88-90**, drive beam **1266** can include integral cam members **1286** which can extend laterally from retention flange **1284**. In at least one embodiment, drive beam **1266** can manufactured from a flat, or at least substantially flat, piece of material where the piece of material can be stamped such that cam members **1286** are at least partially separated from retention flange **1284** and extend in a transverse or oblique direction with respect to drive beam **1266**. In at least one such embodiment, referring to FIG. **90**, cam members **1286** can be sized and configured such that they can slide within anvil channel **1210** and at least assist in holding anvil assembly **1020** in a closed position. In addition to or in lieu of the above, although not illustrated, a portion of drive beam **1266**, for example, can be configured to extend laterally from drive beam **1266** so as to retain drive assembly **1212** to a staple cartridge assembly. In at least one embodiment, similar to the above, retention flanges can be at least partially separated from drive beam **1266** during a stamping process such that the integral retention flanges extend in a transverse or oblique direction with respect to drive beam **1266**. In various embodiments, as a result of the above, at least one integral cam member and/or at least one integral retention member can be formed during a suitable manufacturing process, such as progression stamping, for example, which can reduce, or even eliminate, the assembly time of additional components to the drive beam.

In various embodiments, referring to FIG. **49**, the anvil of a disposable loading unit can include a slot defined therein which can be configured to receive at least a portion of a drive beam. In at least one embodiment, referring to FIGS. **51** and **52**, the anvil can include a channel extending therethrough where cam rollers **286** can be configured to engage a sidewall of the channel and apply a force, or forces, to the anvil assembly. In various circumstances, such forces can cause the anvil to elastically and/or plastically deform and, as a result, affect the deployment of the surgical staples into the soft tissue. In various embodiments of the present invention, an anvil can include features which can eliminate, or at least reduce, the deformation of the anvil. In at least one embodiment, an anvil can include a first member having staple pockets for deforming the staples, a first cover plate secured to the first member, and a second cover plate secured to at least one of the first member and the first cover plate, wherein the first and second cover plates can be configured to support the first member. In at least one such embodiment, referring to FIGS. **91-93**, disposable loading unit **7016** can include anvil assembly **7020** which can comprise anvil portion **204**, first cover plate **208** affixed to anvil portion **204**, and second cover plate **7081** affixed to at least one of anvil portion **204** and first cover plate **208**. In various embodiments, first cover plate **208** can be welded to anvil portion **204** and, in addition, second cover plate **7081** can be welded to first cover plate **208** and/or anvil portion **204**. In at least one embodiment, second cover plate **7081** can strengthen, stiffen, and/or increase the section modulus of the anvil assembly, thereby reducing the possibility that the anvil assembly may unsuitably deform during use.

In various embodiments, referring to FIG. **91**, first cover plate **208** can include tissue stops **208'** extending therefrom. In at least one embodiment, tissue stops **208'** can be configured such that, when the anvil and staple cartridge assemblies are positioned relative to soft tissue, tissue stops **208'** can prevent, or at least inhibit, the soft tissue from progressing past a certain point in the disposable loading unit. In various embodiments of the present invention, referring to FIG. **94**, second cover plate **7081***a* of disposable loading unit **7016***a* can include tissue stops **7081'** extending therefrom in addition to or in lieu of the above. In various embodiments, a disposable loading unit can include a second cover plate which can be formed from one or more sheets of material. In at least one embodiment, referring to FIG. **95**, disposable loading unit **7061***b* can include second cover plate **7081***b*, wherein second cover plate **7081***b* can be formed from a single sheet of material, such as stainless steel, for example. In various embodiments, the sheet of material can be deformed over one or more forming anvils, or mandrels, until it is bent into a suitable shape. In at least one embodiment, the sheet of material can include one or more side edges **7083***b* which can be positioned against or proximal to central portion **7085***b* of second cover plate **7081***b* during the bending process. Thereafter, in at least one such embodiment, side edges **7083***b* can be affixed to central portion **7085***b* by any suitable manufacturing process, such as welding, for example. As a result of the above, in various embodiments, second cover plate **7081***b* can include at least one tissue-contacting edge **7087***b* which is formed at the bend between two portions of the sheet material. In at least one such embodiment, the tissue-contacting edges **7087***b* can have a rounded or radiused profile which can be configured such that the edges do not damage soft tissue. In various embodiments, further to the above, an anvil can be formed from a sheet of material wherein the formed anvil can include a central portion having a first side and a second side and at least two flaps oppositely folded to one another with one flap on the first side and one flap on the second side.

In various embodiments, referring to FIG. **95**, first cover plate **208** and anvil member **204** can define anvil cavity **210** therebetween. In at least one embodiment, as described above, cavity **210** can be configured to receive cam actuators **286** and, in various circumstances, first cover plate **208** can be configured such that there are large gaps between cam actuators **286** and the sidewalls of cavity **210**. In such an embodiment, however, the configuration of first cover plate **208** may not be optimized so as to maximize the moment of inertia of the anvil assembly with respect to axis **7089***b*, for example. As known in the art, a device having a larger moment of inertia with respect to an axis can be more resistant to bending or deformation with respect to that axis. Thus, in various embodiments of the present invention, a cover plate of an anvil assembly can be configured such that the gaps between cam actuators **286** and the cover plate can be eliminated, or at least reduced. In at least one embodiment, referring to FIG. **96**, first cover plate **7208***c* can include at least one base portion **7093***c* and at least one side wall **7095***c* positioned adjacent to, or in abutting contact with, cam actuators **286**. In such embodiments, side walls **7095***c* can extend in a direction so as to increase the moment of inertia of first cover plate **7208***c* with respect to axis **7089***b*. In various embodiments, side wall portions **7095***c* can be oriented in perpendicular, or at least substantially perpendicular, directions with respect to base portions **7093***c*.

In various embodiments, further to the above, an anvil assembly can include a first and/or second cover plate which can include ribs and/or folds therein which can strengthen or stiffen the anvil assembly. In at least one embodiment, referring to FIG. **97**, an anvil assembly of disposable loading unit **7016***d* can include anvil portion **204** and cover plate **7208***d* attached to anvil portion **204**. In various embodiments, cover plate **7208***d* can be include ribs or folds **7097***d* which can increase the moment of inertia of cover plate **7208***d* with respect to axis **7089***b*. In at least one embodiment, cover plate **7208***d* can be manufactured from one or more sheets of material, such as stainless steel, for example, where the sheet, or sheets, can be bent into the configuration illustrated in FIG. **97**. As known in the art, the moment of inertia of a cross-section can be increased by increasing the mass of the cross-section and/or increasing the distance between a mass and a reference axis. The ribs and/or folds **7097***d*, as they can add additional mass at a distance from axis **7089***b*, can add to the moment of inertia of cover plate **7208***d* as compared to cover plate **208**, for example.

In various embodiments, as described above, two or more components of an anvil assembly can be welded together. In at least one embodiment of the present invention, two or more components of an anvil assembly can be press-fit together such that the components are retained to one another. In various embodiments, referring to FIGS. **98-101**, anvil assembly **8020** can include insert portion **8099** and cover portion **8101** where, referring to FIGS. **98** and **100**, insert portion **8099** can be positioned within cavity **8103** defined by cover portion **8101**. Thereafter, referring to FIG. **101**, at least a portion of cover portion **8101** can be deformed, stamped, or swaged such that at least a portion of insert portion **8099** is captured within cavity **8103**. In at least one embodiment, insert portion **8099** can include uneven, rough, and/or corrugated surfaces which can be configured to interlock with portions of cover portion **8101** when it is deformed.

In various embodiments, referring to FIG. **100**, cavity **8103** can include slots or grooves **8105** which can be configured to slidably receive tines **8107** of insert portion **8099** therein, wherein cover portion **8101** can be deformed to capture tines, or arms, **8107** in grooves **8105**. In at least one embodiment, arms **8107** can be press-fit into grooves **8105** where, in various circumstances, such a press-fit can be sufficient to retain insert portion **8099** within cover portion **8101**. In various embodiments, the cover and insert portions of the anvil assembly can be constructed from the same material or different materials. In at least one embodiment, the cover portion can be comprised of a softer or more malleable material than the insert portion. In at least one such embodiment, the cover portion can be at least partially comprised of aluminum, for example, and the insert portion can be at least partially comprised of steel, for example. In either event, the cover portion can be comprised of a material which can be stamped or coined to form the staple-deforming pockets therein. In at least one such embodiment, the cover portion can then be anodized.

In various embodiments, as described above, an anvil assembly can comprise an anvil portion have staple-deforming pockets therein and a cover plate for supporting the anvil portion. In at least one embodiment, the anvil portion and the cover plate can be integrally formed. Referring to FIGS.

102-103, anvil 8020*a* can be manufactured from a tube, or annulus, of material where, in at least one embodiment, at least a portion of the tube, such as portion 8109*a*, for example, can be removed. In at least one such embodiment, the remaining portion of the tube, such as portion 8111*a*, for example, can be deformed utilizing a stamping or forming process such that anvil 8020*a* can include co-planar, or at least substantially co-planar, anvil portions 8204*a* extending from support portion 8208*a*. In various embodiments, the tube can be at least partially comprised of extruded aluminum and, in at least one embodiment, staple-deforming cavities 206 can be formed in the tube prior to and/or after the portion of the tube is removed.

In various embodiments, as described above, an anvil assembly can be comprised of two or more components which are press-fit together. In at least one embodiment, referring to FIGS. 105 and 106, anvil assembly 8020*b* can include a first, or insert, portion 8099*b* and a second, or cover, portion 8101*b*, wherein insert portion 8099*b* can be inserted into cavity 8103*b* of cover portion 8101*b*. In at least one embodiment, the outer surface of insert portion 8099*b* can define a perimeter which is larger than a perimeter defined by an outer surface of outer portion 8101*b* wherein, as a result, insert portion 8099*b* can expand outer portion 8101*b* outwardly when insert portion 8099*b* is inserted into cavity 8103*b*. Owing to such co-operating geometries, a significant normal force can be generated between the surfaces of portions 8099*b* and 8101*b*. In at least one such embodiment, as a result, a significant pulling force may be required to overcome the friction force between members 8099*b* and 8101*b* resulting from the high normal force therebetween.

In various embodiments, an anvil assembly can be comprised of two or more components which are snap-fit together. In at least one embodiment, referring to FIGS. 106-108, anvil assembly 8020*c* can include first portion 8099*c* and second portion 8101*c*, where second portion 8101*c* can be snap-fit to first portion 8099*c*. Referring to FIG. 109, in at least one embodiment, second portion 8101*c* can include projections 8113*c* extending therefrom which can be configured to fit within grooves 8115*c*. In various embodiments, second portion 8101*c* can be at least partially comprised of a resilient material, such as stainless steel, for example, which can allow projections 8113*c* to be displaced outwardly as surface 8117*c* of second portion 8101*c* is moved toward surface 8119*c* of first portion 8099*c*. Once surface 8117*c* is positioned against or adjacent to surface 8119*c*, projections 8113*c* can be resiliently positioned within, or snapped into, grooves 8115*c* such that second portion 8101*c* is retained to first portion 8099*c*. In at least one embodiment, the first and second portions can be comprised of the same material or they can be comprised of different materials. In at least one embodiment, first portion 8099*c* can be at least partially comprised of aluminum and second portion 8101*c* can support the first portion.

In various embodiments, referring to FIG. 86, an anvil can include an anvil member, such as anvil member 4204, for example, which can include ribs or ridges 4153 extending therefrom. In at least one embodiment, ribs 4153 can increase the moment of inertia or cross-sectional modulus of anvil member 4204, for example, such that anvil assembly 4020 is less susceptible to unwanted deformation. In various embodiments, ribs 4153 can extend around the perimeter of anvil member 4204.

In various embodiments, although not illustrated, other components can be assembled to an anvil. In at least one embodiment, a soft or pliable nosepiece, for example, can be assembled to the anvil in order to reduce the possibility that the anvil may damage soft tissue when it is inserted into a surgical site. In at least one such embodiment, the nosepiece, or any other suitable component, can be comprised of any suitable material such as rubber and/or nylon, for example.

In various embodiments, as described above, cam actuators 286, for example, can be configured to engage an anvil assembly and position the anvil assembly against soft tissue positioned intermediate the anvil assembly and a staple cartridge. In at least one embodiment of the present invention, referring to FIGS. 104 and 105, anvil assembly 8020*b*, for example, can include contact surface, or surfaces, 8121*b*, wherein cam actuators 286 can be configured to engage contact surfaces 8121*b* and hold anvil assembly 8020*b* in a closed position. In various embodiments, contact surfaces 8121*b* can be configured such that they extend inwardly toward drive beam 1266 such that at least a portion of the contact surfaces are positioned adjacent to, or in contact with, drive beam 1266. In at least one embodiment, as a result, contact surfaces 8121*b* can be configured such that the contact area between cam actuators 286 and contact surfaces 8121*b* can be maximized, or at least increased. As a result of the increased contact area, the stress or pressure applied by actuators 286 to contact surfaces 8121*b* can be reduced and the possibility of galling and/or localized yielding of the anvil assembly can be reduced.

In various circumstances, especially during endoscopic or laparoscopic surgical procedures, for example, at least a portion of a surgical stapling instrument can be inserted through a cannula, or trocar, into a surgical site. Often, an anvil of a disposable loading unit is moved into its closed position before it is inserted into the trocar and then reopened after it has been inserted therethrough. Some disposable loading units having large anvils and/or staple cartridges may not fit, or easily fit, through the trocar even when the anvil is in the closed position. In various embodiments of the present invention, a surgical stapling instrument can include a disposable loading unit having an anvil which can be moved between open, closed, and/or collapsed positions to facilitate the insertion of the disposable loading unit through the trocar. More particularly, in at least one embodiment, an anvil can be moved into a closed position in which the anvil is a first distance away from the staple cartridge, for example, and a collapsed position in which the anvil is closer to the staple cartridge such that the disposable loading unit can be more easily inserted through the trocar.

In various embodiments of the present invention, further to the above and referring to FIGS. 114-116, a disposable loading unit 9016 can include anvil assembly 9020 and staple cartridge assembly 9018, wherein anvil assembly 9020 can be rotatably mounted relative to staple cartridge assembly 9018. In use, similar to the above, drive assembly 212 can be advanced distally such that cam actuators 286 can contact anvil member 9204 and rotate anvil assembly 9020 between an open position, as illustrated in FIGS. 115 and 116, and a closed position, as illustrated in FIGS. 117 and 118. When anvil assembly 9020 is rotated toward staple cartridge assembly 9018, in at least one embodiment, anvil assembly 9020 can be configured to compress at least one return spring 9051, for example, in the disposable loading unit.

In at least one embodiment, referring to FIG. 118, anvil assembly 9020 can further include tissue-contacting surface 9020' and, similarly, staple cartridge assembly 9018 can include tissue contacting surface 9018'. In various embodiments, tissue-contacting surfaces 9018' and 9020' can be separated by a first distance 9121 when anvil assembly 9020 is in a closed position. In order to move anvil assembly **9020** into a collapsed position, in various embodiments, actuator **9043** can be moved distally, for example, such that portion **9049** of actuator **9043** can contact anvil assembly **9020** and push anvil assembly **9020** toward staple cartridge assembly **9018** as illustrated in FIGS. **119** and **120**. In such a collapsed position, in at least one embodiment, tissue-contacting surfaces **9018'** and **9020'** can be separated by a second distance **9125** which can be shorter than first distance **9121**. In various embodiments, actuator **9043** can push anvil assembly **9020** downwardly until surface **9020'** at least partially abuts surface **9018'**.

In various embodiments, further to the above, a disposable loading unit can include at least one return spring which can be compressed when the anvil assembly is moved into its collapsed position. In at least one embodiment, referring to FIGS. **116** and **118**, disposable loading unit **9016** can include springs **9123** which can be compressed when anvil assembly **9020** is moved between its open and closed positions and, referring to FIGS. **118** and **120**, further compressed when anvil assembly is moved into its collapsed position. Once the anvil assembly is in its collapsed position, the disposable loading unit can be inserted into a trocar, which is represented in dash as circle **9155** in FIG. **121**. After at least a portion of anvil assembly **9020** and staple cartridge assembly **9018** have passed through the trocar, actuator **9043** can be disengaged from anvil assembly **9020** to allow springs **9123** to move anvil assembly from its collapsed position into its closed position, as illustrated in FIG. **122**. Furthermore, cam actuators **286** can be sufficiently disengaged from anvil assembly **9020** to allow springs **9051** to move anvil assembly **9020** into its open position such that the anvil and staple cartridge assemblies can be positioned relative to soft tissue.

In various embodiments, as outlined above, cam actuators **286** can be utilized to move anvil assembly **9020** between an open position and a closed position and, thereafter, actuator **9043** can be utilized to move anvil assembly **9020** between the closed position and a collapsed position. Alternatively, actuator **9043** can be configured such that it can engage anvil assembly **9020** when it is in its open position and move anvil assembly **9020** directly into its collapsed position. In various circumstances, such embodiments can allow a surgeon to more quickly and easily configure a disposable loading unit to be inserted through a trocar. In at least one such embodiment, after at least a portion of the anvil assembly has been inserted through the trocar, the actuator can be sufficiently disengaged from the anvil assembly such that the anvil assembly can be moved directly into is open position and positioned relative to soft tissue, for example. In order to remove the disposable loading unit from the surgical site, the actuator can be reengaged with the anvil assembly to move the anvil assembly into its collapsed position such that the disposable loading unit can be withdrawn through the trocar.

With respect to the disposable loading units and surgical instruments described further above, referring to FIGS. **41** and **42**, a disposable loading unit can be inserted into the distal end of a surgical instrument and can be rotated with respect to the surgical instrument in order to operably engage the drive assembly and/or articulation link of the disposable loading unit with the surgical instrument. In at least one embodiment of the present invention, such rotation can unlock the drive assembly and allow the drive assembly to be advanced distally as described above. Referring to FIG. **123**, disposable loading unit **10016** can include anvil assembly **10020**, shaft assembly **10125**, and lockout device **10127**, where lockout device **10127** can be engaged with drive assembly **10212** (FIG. **128**) prior to disposable loading unit **10016** being rotated relative to elongated body **14** (FIG. **1**) of the surgical instrument. In at least one such embodiment, referring to FIG. **124**, lockout device **10127** can include key **10131** which can be configured to engage a recess in drive assembly **10212**, for example, so as to prevent, or at least inhibit, drive assembly **10212** from being advanced distally prior to disposable loading unit **10016** being rotated. As disposable loading unit **10016** is rotated, key **10131** can be disengaged from drive assembly **10212** and, as a result, drive assembly **10212** can be advanced distally as described above.

In various embodiments, referring to FIGS. **123** and **124**, lockout device **10127** can include arms **10129** extending therefrom which, prior to the rotation of disposable loading unit **10016**, can be aligned, or at least substantially aligned, with nubs **254** extending from shaft assembly **10125**. In at least one embodiment, referring to FIGS. **125** and **126**, arms **10129** and nubs **254** can be inserted into slots **10133** in elongated body **14**, for example, when disposable loading unit **10016** is inserted into elongated body **14**. When disposable loading unit **10016** is rotated, referring to FIG. **127**, arms **10129** can be sufficiently confined within slots **10133** such that slots **10133** can hold them in position, whereas nubs **254** can be positioned such that they are not confined within slots **10133** and can be rotated relative to arms **10129**. In effect, elongated body **14** can hold lockout device **10127** in position and, when shaft assembly **10125** is rotated with disposable loading unit **10016**, drive assembly **10212** can be rotated away from key **10131** of lockout device **10127**.

To detach disposable loading unit **10116** from elongated member **14**, disposable loading unit **10016**, and shaft assembly **10125**, can be rotated in an opposite direction such that nubs **254** are at least substantially realigned with arms **10129** and, as a result, nubs **254** and arms **10129** can be withdrawn from slots **10133**. Such circumstances can typically arise after the disposable loading unit has been used, or expended, and the surgeon, or other clinician, desires to assemble a new disposable loading unit to the elongated body. In various circumstances, though, the surgeon, or other clinician, may become confused as to whether a disposable loading unit has been previously expended. In various embodiments of the present invention, the lockout device described above, or any other suitable lockout device disclosed herein, can be utilized to prevent, or at least inhibit, an expended disposable loading unit from being reassembled to the elongated body of the surgical instrument.

In various embodiments, referring to FIG. **128**, disposable loading unit **10016** can further include biasing spring **10135**, actuator **10137**, and actuator plate **10139** extending from actuator **10137**, wherein actuator plate **10139** can be configured to operably engage spring **10135**. After disposable loading unit **10116** has been operably engaged with elongated portion **14**, as described above, drive assembly **10212** can be advanced distally to staple and/or incise tissue. In at least one embodiment, actuator **10137** can be operably attached to drive assembly **10212** such that, when drive assembly **10212** is advanced, drive assembly **10212** can pull actuator **10137** and actuator plate **10139** distally as well. Once drive assembly **10212** has been sufficiently advanced, referring to FIG. **129**, actuator plate **10139** can be sufficiently disengaged from biasing spring **10135** so as to release biasing spring **10135** from a compressed state and allow biasing spring **10135** to apply a biasing force against lockout device **10127**. However, at such point, as lockout device **10127** is held in position by elongated member **14**, as described above, the biasing force applied by spring **10135** cannot move, or at least substantially move, lockout device **10127**, at least as long as disposable loading unit **10016** remains engaged with elongated member **14**.

In various embodiments, the disengagement of actuator plate **10139** from biasing spring **10135** can occur before, or at the exact moment, in which a staple can de deployed from the staple cartridge and/or the cutting member can incise the tissue. In at least one such embodiment, a surgeon could advance and retract drive assembly **10212** in order to position anvil assembly **10020** relative to soft tissue without triggering the lockout assembly described above. After actuator **10137** has been sufficiently advanced to disengage plate **10139** from spring **10135**, drive assembly **10212** can be further advanced distally such that, referring again to FIG. **129**, actuator **10137** and/or actuator plate **10139** can abut a shoulder, for example, within the disposable loading unit. In at least one such embodiment, the shoulder can prevent actuator **10137** and actuator plate **10139** from being advanced further within the disposable loading unit. Upon further advancement of drive assembly **10212**, however, actuator **10137** can become operably detached from drive assembly **10212** such that the advancement of drive assembly **10212** is not transmitted to actuator **10137**.

After disposable loading unit **10016** has been disengaged from elongated member **14**, referring to FIG. **130**, biasing spring **10135** can move, or rotate, locking device **10127** into a position in which arms **10129** are no longer aligned with nubs **254**. In at least one such embodiment, such a disposable loading unit **10016** cannot be readily reassembled to elongated member **14** as arms **10129** and nubs **254** would not both fit within slots **10133** owing to their relative misalignment. In various embodiments, such disposable loading units can provide the surgeon, or other clinician, with immediate feedback that they are attempting to assemble an expended, or possibly defective, disposable loading unit to a surgical instrument. Such embodiments can ameliorate the circumstances where an at least partially expended disposable loading unit is reassembled to a surgical instrument and reinserted into a surgical site only for the surgeon to then discover that the disposable loading unit has been expended. In various embodiments, drive assembly **10212** and actuator **10137** can be configured such that, in the event that drive assembly **10212** is retracted, drive assembly **10212** may not cause actuator **10137** to reengage biasing spring **10135** and return biasing spring **10135** to its compressed state.

In various embodiments, referring primarily to FIG. **126**, slots **10133** of elongated member **14** can include a substantially rectangular profile which extends along the length thereof. While suitable for its intended purpose, circumstances may arise where it may be difficult to assemble the disposable loading unit to the elongated member. More particularly, in at least one embodiment, the disposable loading unit can be configured such that a surgeon, or other clinician, can not readily observe whether nubs **254** are aligned with slots **10133** and the surgeon may have spend time to precisely align nubs **254** with slots **10133** before assembling the disposable loading unit to elongated member **14**. In at least one embodiment of the present invention, referring to FIG. **64**, elongated member **14'** can include slots **10133'** having radiused and/or beveled ends **10141'** which can facilitate the insertion of nubs **254** into slots **10133'** and reduce the time and/or effort that a surgeon must expend to align and assemble the disposable loading unit to the surgical instrument.

As described above, a disposable loading unit can be detached from a surgical instrument after it has been at least partially expended and a new disposable loading unit can be attached to the surgical instrument such that the surgical instrument can be reused. In various embodiments, previous disposable loading units have included a housing, an anvil assembly, and a staple cartridge assembly, as outlined above, and, in addition, a staple driver for deploying staples from the staple cartridge assembly and a cutting member for incising tissue. When the staple cartridge assemblies of such disposable loading units are at least partially expended, the remainder of the disposable loading unit, such as the housing, the anvil assembly, the staple driver, and the cutting member, for example, are typically discarded along with the expended staple cartridge assembly. As a result, significant cost and undue waste can be expended to replace such previous disposable loading units.

In various embodiments of the present invention, a disposable loading unit can include a replaceable staple cartridge. In at least one embodiment, referring to FIGS. **131-135**, disposable loading unit **11016** can include anvil assembly **11020**, staple cartridge channel **11216**, and staple cartridge **11018**, wherein staple cartridge **11018** can be removably attached to staple cartridge channel **11216**. In at least one embodiment, as a result, a first staple cartridge **11018** can be replaced with a second staple cartridge **11018**, or another suitable staple cartridge, such that one or more of the various other portions of the disposable loading unit can be reused. In various embodiments, referring to FIG. **132**, staple cartridge **11018** can be snap-fit into staple cartridge channel **11216** such that staple cartridge **11018** can be reliably retained within, yet easily removed from, staple cartridge channel **11216**.

In at least one embodiment, staple cartridge **11018** can include body portion **11143** having at least one staple cavity for removably storing at least one staple therein and, in addition, cartridge pan **11145** which can be attached to body portion **11143**. In various embodiments, cartridge pan **11145** can be snap-fit and/or press-fit to body portion **11143** to prevent, or at least inhibit, the staples within the staple cavities from falling out of the bottom of body portion **11143**. In at least one embodiment, body portion **11143** and/or cartridge pan **11145** can include one or more projections **11147** and/or apertures **11149** which can be configured to retain body portion **11143** and cartridge pan **11145** to one another. In various embodiments, cartridge pan **11145** can further include projections or dimples **11151**, for example, which can be configured to engage staple cartridge channel **11216** and retain staple cartridge **11018** thereto.

In various embodiments, as described above, staple driver **232** and cutting member **280** can be advanced distally to deploy staples from the staple cartridge and incise soft tissue. Thereafter, in at least one embodiment of the present invention, staple driver **232** and cutting member **280** can be retracted relative to the staple cartridge such that, when the staple cartridge is replaced, staple driver **232** and cutting member **280** can be advanced distally once again into the new staple cartridge. In various embodiments, the staple driver and/or cutting member can remain in the spent staple cartridge as the staple cartridge is being removed and the new staple cartridge can include a new staple driver positioned therein. In at least one such embodiment, each staple cartridge can include a staple driver and a cutting member positioned therein such that the staple driver and cutting member of a spent staple cartridge do not have to be reused. Such embodiments can be useful when the staple driver and the cutting member can be damaged and/or dulled during their use. In various embodiments, the staple driver and the cutting member can comprise an assembly. In at least one such embodiment, the cutting member can be snap-fit and/or press-fit into the staple driver. In other embodiments, the cutting member can be comprised of a plastic material, for example, which is overmolded onto the cutting member.

As described above, an anvil assembly of a disposable loading unit can include one or more pockets therein for deforming at least one staple when it is ejected from the staple cartridge. In various embodiments of the present invention, an anvil can be attached to the disposable loading unit such that it cannot be readily detached from the disposable loading unit even though the staple cartridge may be readily removable. In various circumstances, however, the anvil may become worn after a single use and/or multiple uses. In at least one embodiment of the present invention, at least a portion of an anvil assembly can be configured such that it can be detached from disposable loading unit and replaced with a new portion of the anvil assembly. In at least one such embodiment, the anvil assembly and the staple cartridge can both be replaced before a disposable loading unit is reused. In various embodiments, further to the above, a disposable loading unit can include a staple cartridge channel, or at least a portion of a staple cartridge channel, which is detachable from the disposable loading unit. In at least one such embodiment, the staple cartridge channel, or a portion of the staple cartridge channel, can be replaced along with a staple cartridge.

When a staple cartridge and/or anvil of a disposable loading unit is replaced, in various embodiments of the present invention, the staple cartridge and anvil can be replaced with an identical, or at least nearly identical, staple cartridge and anvil. In at least one such embodiment, for example, a 30 mm staple cartridge can be replaced with another 30 mm staple cartridge. In at least one embodiment, however, the staple cartridge and/or anvil can be replaced with a different staple cartridge and anvil. In at least one such embodiment, a 30 mm staple cartridge can be replaced with a 45 mm staple cartridge. Such embodiments may be particularly useful when the anvil assembly and/or staple cartridge channel are also replaced to accommodate the different staple cartridge. Other embodiments are envisioned in which a staple cartridge is replaced with a staple cartridge having a different quantity and/or arrangement of staples stored therein. In such embodiments, similar to the above, at least a portion of the anvil assembly can be replaced to accommodate such a staple cartridge. In various embodiments, sets of anvils and staple cartridges can be provided for and/or with a disposable loading unit. In at least one such embodiment, a rigid anvil can be provided for use with a staple cartridge containing staples which will require a large force to deform the staples. In other various embodiments, an anvil can be provided having specialized staple-deforming pockets which are particularly designed to deform a particular staple, such as staples with long staple legs, for example. In at least one embodiment, the anvil and staple cartridge can include corresponding indicia, such as colors, numbers, and/or symbols, etc. which can allow a surgeon, or other clinician, to readily identify matching pairs of anvils and staple cartridges.

Several of the disposable loading unit embodiments described above have been exemplified with an anvil having a distal end which is movable relative to a distal end of a staple cartridge. In various alternative embodiments, although not illustrated, a disposable loading unit can include an anvil and a staple cartridge wherein the anvil can include a distal end which is pivotably mounted relative to the staple cartridge at its distal end. In at least one embodiment, the disposable loading unit can include an actuator which can be displaced distally to engage the anvil and rotate the anvil between an open position and a closed position. In at least one such embodiment, the staple cartridge can include a staple cartridge and/or a cutting member which can be displaced from a position located near the distal end of the anvil to a proximal end of the anvil. In at least one such embodiment, as a result, a surgeon can more readily observe whether soft tissue has been properly positioned between and/or treated within the staple cartridge and anvil.

The devices disclosed herein can be designed to be disposed of after a single use, or they can be designed to be used multiple times. In either case, however, the device can be reconditioned for reuse after at least one use. Reconditioning can include any combination of the steps of disassembly of the device, followed by cleaning or replacement of particular pieces, and subsequent reassembly. In particular, the device can be disassembled, and any number of the particular pieces or parts of the device can be selectively replaced or removed in any combination. Upon cleaning and/or replacement of particular parts, the device can be reassembled for subsequent use either at a reconditioning facility, or by a surgical team immediately prior to a surgical procedure. Those skilled in the art will appreciate that reconditioning of a device can utilize a variety of techniques for disassembly, cleaning/replacement, and reassembly. Use of such techniques, and the resulting reconditioned device, are all within the scope of the present application.

Preferably, the invention described herein will be processed before surgery. First, a new or used instrument is obtained and if necessary cleaned. The instrument can then be sterilized. In one sterilization technique, the instrument is placed in a closed and sealed container, such as a plastic or TYVEK bag. The container and instrument are then placed in a field of radiation that can penetrate the container, such as gamma radiation, x-rays, or high-energy electrons. The radiation kills bacteria on the instrument and in the container. The sterilized instrument can then be stored in the sterile container. The sealed container keeps the instrument sterile until it is opened in the medical facility.

It will be understood that various modifications may be made to the embodiments disclosed herein. For example, the stapling apparatus need not apply staples but rather may apply two part fasteners as is known in the art. Further, the length of the linear row of staples or fasteners may be modified to meet the requirements of a particular surgical procedure. Thus, the length of a single stroke of the actuation shaft and/or the length of the linear row of staples and/or fasteners within a disposable loading unit may be varied accordingly. Therefore, the above description should not be construed as limiting, but merely as exemplifications of preferred embodiments. Those skilled in the art will envision other modifications within the scope and spirit of the claims appended thereto.

What is claimed is:

1. A surgical stapling assembly, comprising:

a shaft comprising an attachment interface, wherein said surgical stapling assembly is configured to be attached to a surgical instrument interface by way of said attachment interface;

a firing member;

an end effector extending from said shaft, wherein said end effector comprises:

a staple cartridge comprising a plurality of staples configured to be ejected by said firing member;

a first jaw;

a second jaw movable relative to said first jaw between:
an open position;
a fully-clamped position; and
a collapsed position; and
an interconnection between said first jaw and said second jaw defining a rotational axis about which said second jaw is movable relative to said first jaw, wherein said rotational axis is shiftable toward and away from said first jaw as said second jaw is moved between said open position, said fully-clamped position, and said collapsed position; and
a closure member configured to move said second jaw from said open position to said collapsed position when said closure member moves from a proximal position to a distal position.

2. The surgical stapling assembly of claim 1, wherein said proximal position comprises a first proximal position, wherein said closure member is movable from said distal position to a second proximal position to move said second jaw from said collapsed position to said open position, and wherein said first proximal position and said second proximal position are different.

3. A surgical stapling assembly, comprising:
a shaft comprising an attachment interface, wherein said surgical stapling assembly is configured to be attached to a surgical instrument interface by way of said attachment interface;
a firing member;
an end effector extending from said shaft, wherein said end effector comprises:
a staple cartridge comprising a plurality of staples configured to be ejected by said firing member;
a first jaw; and
a second jaw movable relative to said first jaw between:
an open position;
a fully-clamped position; and
a collapsed position; and
a closure member configured to move said second jaw from said open position to said collapsed position when said closure member moves from a proximal position to a distal position,
wherein said surgical stapling assembly is attached to the surgical instrument interface by way of a twisting motion.

4. A surgical stapling assembly, comprising:
a shaft comprising an attachment interface, wherein said surgical stapling assembly is configured to be attached to a surgical instrument interface by way of said attachment interface;
a firing actuator;
an end effector extending from said shaft, wherein said end effector comprises:
a staple cartridge comprising a plurality of staples configured to be ejected by said firing actuator;
a first jaw; and
a second jaw defining a rotational axis about which said second jaw is movable relative to said first jaw between:
an unclamped position defining a first distance between said first jaw and said second jaw;
a fully-clamped position defining a second distance between said first jaw and said second jaw; and
a closed position defining a third distance between said first jaw and said second jaw, wherein said first distance is greater than said second distance, wherein said second distance is greater than said third distance, and wherein said rotational axis is movable toward and away from said first jaw as said second jaw is moved between said unclamped position, said fully-clamped position, and said closed position; and
a closure actuator configured to move said second jaw from said unclamped position to said closed position when said closure actuator moves from a proximal position to a distal position.

5. The surgical stapling assembly of claim 4, wherein said proximal position comprises a first proximal position, wherein said closure actuator is movable from said distal position to a second proximal position to move said second jaw from said closed position to said unclamped position, and wherein said first proximal position and said second proximal position are different.

6. A surgical stapling assembly, comprising:
a shaft comprising an attachment interface, wherein said surgical stapling assembly is configured to be attached to a surgical instrument interface by way of said attachment interface;
a firing actuator;
an end effector extending from said shaft, wherein said end effector comprises:
a staple cartridge comprising a plurality of staples configured to be ejected by said firing actuator;
a first jaw; and
a second jaw movable relative to said first jaw between:
an unclamped position defining a first distance between said first jaw and said second jaw;
a fully-clamped position defining a second distance between said first jaw and said second jaw; and
a closed position defining a third distance between said first jaw and said second jaw, wherein said first distance is greater than said second distance, wherein said second distance is greater than said third distance; and
a closure actuator configured to move said second jaw from said unclamped position to said closed position when said closure actuator moves from a proximal position to a distal position,
wherein said surgical stapling assembly is attached to the surgical instrument interface by way of a twisting motion.

7. A surgical stapling assembly, comprising:
a shaft;
a firing member comprising a first clamping member;
an end effector extending from said shaft, wherein said end effector comprises:
a staple cartridge comprising a plurality of staples configured to be ejected by said firing member;
a first jaw; and
a second jaw defining a rotational axis about which said second jaw is movable relative to said first jaw between:
an unclamped position defining a first distance between said first jaw and said second jaw;
a fully-clamped position defining a second distance between said first jaw and said second jaw; and
a closed position defining a third distance between said first jaw and said second jaw, wherein said first distance is greater than said second distance, wherein said second distance is greater than said third distance, and wherein said rotational axis is movable toward and away from said first jaw as said second jaw is moved between said unclamped position, said fully-clamped position, and said closed position; and

a closure member comprising a second clamping member, wherein said closure member is configured to move said second jaw from said unclamped position to said closed position when said closure member moves from a proximal position to a distal position.

8. The surgical stapling assembly of claim **7**, wherein said proximal position comprises a first proximal position, wherein said closure member is movable from said distal position to a second proximal position to move said second jaw from said closed position to said unclamped position, and wherein said first proximal position and said second proximal position are different.

9. A surgical stapling assembly, comprising:

a shaft;

a firing member comprising a first clamping member;

an end effector extending from said shaft, wherein said end effector comprises:

a staple cartridge comprising a plurality of staples configured to be ejected by said firing member;

a first jaw; and

a second jaw movable relative to said first jaw between:

an unclamped position defining a first distance between said first jaw and said second jaw;

a fully-clamped position defining a second distance between said first jaw and said second jaw; and

a closed position defining a third distance between said first jaw and said second jaw, wherein said first distance is greater than said second distance, and wherein said second distance is greater than said third distance; and

a closure member comprising a second clamping member, wherein said closure member is configured to move said second jaw from said unclamped position to said closed position when said closure member moves from a proximal position to a distal position,

wherein said shaft comprises an attachment interface, wherein said surgical stapling assembly is configured to be attached to a surgical instrument interface by way of said attachment interface by way of a twisting motion.

* * * * *